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CONTRACT NUMBER DAMD17-92-C-2066

TITLE: Evaluation of Biomonitoring Systems for Assessment of Contaminated Water and Sediments at U.S. Army Installations - Aquatic Toxicity Evaluation of Selected Sites During High Surficial Aquifer Flow at J-Field Aberdeen Proving Ground - Edgewood Area

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REPORT DATE: September 12, 1997

TYPE OF REPORT: Interim

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Maryland 21702-5012

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 12, 1997	Annual Report (31 Jul 96 - 17 Aug 97)

4. TITLE AND SUBTITLE Evaluation of Biomonitoring Systems for Assessment of Contaminated Water and Sediments at U.S. Army Installations - Aquatic Toxicity Evaluation of Selected Sites During High Surficial Aquifer Flow at J-Field Aberdeen Proving Ground-Edgewood Area.

5. FUNDING NUMBERS
DAMD17-92-C-2066

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8. PERFORMING ORGANIZATION REPORT NUMBER
WREC-97-05

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Medical Research and Materiel Command
Fort Detrick
Frederick, MD 21702-5012

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)* The surficial aquifer in the vicinity of the toxic burning pits (TBP) at J-Field, Aberdeen Proving Ground, Maryland, is contaminated with a number of chlorinated aliphatic hydrocarbons. The steepest hydraulic gradient in the TBP area is to the southeast toward a marsh. Recharge of the aquifer appears to be greatest in the winter and least in the summer. Flow reversals may take place in the summer. Toxicity in the marsh has been previously detected by several studies. The current study was initiated to define potential toxicity to the marsh ecosystem that may occur as a result of changes in the seasonal flow pattern of the contaminated surficial aquifer discharge into the marsh under high and low aquifer flow conditions. The toxicity of the marsh surface waters, marsh surficial sediments, and a highly contaminated surficial aquifer well up-gradient from the TBP marsh under high aquifer flow conditions, were similar to those observed in previous studies. The current study did show, however, that all three media caused malformations in a frog assay which had not previously been reported. Chemical analyses showed that the chemicals of concern were within an order of magnitude or less of those previously reported.

14. SUBJECT TERMS	15. NUMBER OF PAGES
Acute toxicity, chronic toxicity, sediment toxicity, algae, cladocera, amphipods, fish, FETAX, groundwater, priority pollutants, heavy metals, Chlorinated aliphatic hydrocarbons, VOCs.	268
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

FOREWORD

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D.T. Burton
Principal Investigator's Signature

9-12-97
Date

Certification of Technical Data Conformity (May 1987)

The contractor, University of Maryland at College Park, hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract DAMD17-92-C-2066 is complete, accurate, and complies with all requirements of the contractor.

Date: September 12, 1997

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EXECUTIVE SUMMARY

The surficial aquifer in the vicinity of the toxic burning pits (TBP) at J-Field, Aberdeen Proving Ground, Maryland, is contaminated with a number of chlorinated aliphatic hydrocarbons. Groundwater flow measurements at J-Field have shown that the flow is generally from topographically high areas to topographically low areas. In the TBP area, the shallow water table has a local high in the area between the main burning pits and the Prototype Building. The steepest hydraulic gradient in the TBP area is to the southeast toward the marsh.

The major influences on the surficial aquifer flow system are recharge by infiltration of precipitation, evapotranspiration, and tidal fluctuations. Effective recharge appears to be greatest in the winter and least in the summer. The water level in the surficial aquifer in the TBP area is over 6 ft above mean sea level (MSL) during a wet springtime and approximately 1 ft below MSL during August and September when high evapotranspiration rates prevail. During the summer, flow reversals may take place with flow from the tidal estuaries providing recharge to the aquifer. Thus, one may infer that the southeast flow of contaminants into the marsh during these periods may be considerably reduced.

A series of aquatic bioassays were conducted at J-Field during the spring of 1994 and 1995 on surface water and surficial sediments obtained from areas likely to receive surface water runoff from the TBP area. Toxicity was detected by several bioassay systems in the TBP area of the marsh east of the TBP Pushout Area where the steepest hydraulic gradient of the surficial aquifer occurs. The current study was designed to define potential toxicity to the marsh ecosystem that may occur as a result of changes in the seasonal flow pattern of the contaminated surficial aquifer discharge into the marsh under high and low aquifer flow conditions (i.e., spring and late summer). The high aquifer flow phase of the study was completed as scheduled. However, the low flow phase could not be conducted because the marsh was dry during the low flow period (lowest rainfall in 30 years).

Aqueous phase bioassays were conducted on marsh surface water samples taken from three sites (SW-10, SW-11, and SW-12) east of the TBP Pushout Area and groundwater from a highly contaminated well ungradient from the TBP area (well JF8-3). A sediment phase bioassay was conducted on a composite sediment sample taken from the middle (SW-11) of the three surface-water sites. A sediment bioassay was also run on sediment taken from South Beach located due south of the TBP area approximately 50 feet offshore (<3 feet deep MSL). Comprehensive chemical and munitions analyses were also performed on all media analyzed for

toxicity. The 1997 spring results of this study were compared to the toxicity and chemical data from previous spring studies at the same sites.

Definitive acute aqueous phase bioassays were conducted with a cladoceran (Ceriodaphnia dubia), fathead minnow (Pimephales promelas), and African clawed frog (Xenopus laevis). The results of the assays were quite consistent with the screening and definitive bioassays conducted in the spring of 1994 with a cladoceran (Daphnia magna), fathead minnow, and southern leopard frog (Rana sphenocephala). Both studies show that the surface waters at the three sites are not acutely toxic to cladocera and frogs. Two of the three sites (SW-10 and SW-12) are not acutely toxic to fathead minnow. The third site (SW-11) was not found to be toxic in the 1994 study during a 48-h screening test; a definitive acute test conducted in 1997 showed that the surface water was toxic to fathead minnow after a 96-h exposure.

Chronic toxicity tests conducted during the spring of 1997 on surface water from the same three sites showed the following. Briefly, both the 1994 and 1997 studies showed that the surface waters at the three marsh sites (SW-10, SW-11, and SW-12) in the vicinity of the TBP Pushout Area are chronically toxic to the green alga (Selenastrum capricornutum). Two of the three sites (SW-10 and SW-11) did not cause any chronic toxicity in 1997 to Ceriodaphnia; SW-12 was toxic during a 7-d exposure. No chronic toxicity to Ceriodaphnia was found at the three sites in the 1995 study.

All three sites caused chronic toxicity to the fathead minnow in 1997. Chronic toxicity was also found in the 1994 study at SW-10; chronic toxicity to the fathead minnow was not found at SW-11 and SW-12 in 1994. As stated above, the marsh surface waters at SW-10, SW-11, and SW-12 were not acutely toxic to frogs. Although the waters from the three sites did not cause significant mortality to frogs, significant increases in frog embryo malformations were found in teratogenic assays at all three sites in 1997.

Surficial sediment taken from SW-11 was not toxic to the amphipod Hyalella azteca during a 28-d chronic exposure in the current study. A 28-d sediment study conducted in 1995 with the same species of amphipod found that SW-11 sediment was toxic (reduction in growth occurred). As in the current 28-d study, a 10-d acute sediment test conducted in May 1994 also showed that SW-11 sediment was not toxic H. azteca. Chronic sediment tests run in 1995 showed that sediments from SW-10 and SW-12 were not toxic to H. azteca during 28-d exposures. Sediment from SW-12 was found to be toxic to the amphipod in 1994 during a 10-d acute test.

Sediment from South Beach did not cause any chronic toxicity to the amphipod (H. azteca). EPA conducted a 10-d toxicity test with the saltwater amphipod Ampelisca abdita on sediment taken in August 1992 from the same general area as the current test. Although 35% of the treatment organisms died during the test, EPA concluded that the mortality was probably related to habitat preference (i.e., physical sediment variables) rather than potential toxicants bound to organic carbon. Screening level bioassays (May to June 1993) on pore water taken from sediments in the same general area of South Beach have also shown that the sediments are not toxic.

As expected, the contaminated groundwater from the well (JF8-3) up-gradient from the TBP marsh area was found to be acutely and chronically toxic to all organisms tested in 1997. Likewise, the 1994 study also showed that groundwater from the same well caused acute toxicity to the alga, cladoceran, fathead minnow, and frog.

Comprehensive chemical analyses and munitions analyses were performed on surface water taken from SW-10, SW-11, and W-12; groundwater from well JF8-3; and sediments taken from SW-11 and South Beach. The comprehensive chemical analyses included general chemistry, metals, volatile organics, base neutrals, acid compounds, pesticides/PCBs, and herbicides. Nitroaromatics and nitramines were determined in the munitions analyses. The results of the chemical analyses conducted in the current study were very similar to the results reported in prior studies for the three marsh sites, well JF8-3, and South Beach.

In summary, the current study supports the toxicological findings of previous studies. With regard to the marsh adjacent to the TBP Pushout Area, earlier screening studies did not identify toxicity to frogs. The current definitive toxicity study also showed that statistically significant mortality did not occur to frogs; however, malformations occurred at all Pushout Area marsh sites. Likewise, the current study showed that short-term chronic toxicity occurred to fish at two of three sites that in the past were not found to be chronically toxic to fish. Although well JF8-3 upgradient from the Pushout Area contains toxic concentrations of volatile organic compounds, chemical data from the current study for the marsh sites indicate that heavy metals are the primary contaminants of concern in the Pushout Area boundary of the marsh. Argonne National Laboratory's focus feasibility study of the TBP site indicates that the source of heavy metals in the Pushout Area of the marsh is primarily from surface runoff from the adjacent contaminated soils. The current study supports Argonne National Laboratory's draft remedial investigation conclusion that ecological receptors are at risk in the marsh adjacent to the TBP Pushout Area.

ACKNOWLEDGEMENTS

We thank Mr. Tommy R. Shedd (COR) of the U.S. Army Center for Environmental Health Research (USACEHR), Fort Detrick, Frederick, Maryland, for his continual support and help throughout the study. Mr. Alan B. Rosencrance of USACEHR is acknowledged for conducting the munitions analyses. Thanks are extended to Ms. Margaret W. Toussaint of Geo-Centers, Inc., Frederick, Maryland, for the quality assurance audit of the data. We would also like to thank Mr. Chris Jacobs and John G. Wrobel of the Environmental Preservation, Conservation and Restoration Division of the Directorate of Safety, Health and Environment, Aberdeen Proving Ground, Maryland, for their help during the study. We acknowledge USACEHR for supporting the study through U.S. Army Contract No. DAMD17-92-C-2066.

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SECTION 1

INTRODUCTION

The surficial aquifer in the vicinity of the toxic burning pits (TBP) at J-Field is contaminated with a number of chlorinated aliphatic hydrocarbons (ANL, 1995). Groundwater flow measurements at J-Field have shown that the flow is generally from topographically high areas to topographically low areas (Hughes, 1993). In the TBP area, the shallow water table has a local high in the area between the main burning pits and the Prototype Building (Fig. 1). The steepest hydraulic gradient in the TBP area is to the southeast toward the marsh. Preliminary thermal imagery also suggests that groundwater discharges to the marsh (ANL, 1995).

The major influences on the surficial aquifer flow system are recharge by infiltration of precipitation, evapotranspiration, and tidal fluctuations. Effective recharge appears to be greatest in the winter and least in the summer. The water level in the surficial aquifer in the TBP area is over 6 ft above mean sea level (MSL) during a wet springtime and approximately 1 ft below MSL during August and September when high evapotranspiration rates prevail. During the summer, flow reversals may take place with flow from the tidal estuaries providing recharge to the aquifer. Thus, one may infer that the southeast flow of contaminants into the marsh during these periods may be considerably reduced.

A series of aquatic bioassays have been conducted at J-Field during the spring of 1994 and 1995 (Hayse, 1995; ESI, 1995a-c) . The bioassays were conducted on surface water and surficial sediments obtained from areas likely to receive surface water runoff from the TBP Pushout Area and other areas of potential toxicity. A number of trophic levels were used in the evaluations. Several of the tests showed that relatively little acute toxicity occurred at most areas at J-Field. Toxicity was detected by several bioassay systems in the area of the marsh southeast of the TBP Pushout Area where the steepest hydraulic gradient of the surficial aquifer occurs.

The current study was initially designed to define potential toxicity to the marsh ecosystem that may occur as a result of changes in the seasonal flow pattern of the contaminated surficial aquifer discharge into the marsh under high and low aquifer flow conditions (i.e., spring and late summer). The high aquifer flow phase of the study was completed as scheduled. However, the low flow phase could not be conducted because the marsh was dry (lowest rainfall in 30 years) during the low flow period (August and September).

SECTION 2

MATERIALS AND METHODS

Aqueous phase and sediment phase bioassays were conducted at J-Field. Aqueous phase bioassays were conducted on marsh surface samples taken from sites SW-10, SW-11, and SW-12 and groundwater from well JF8-3 (Fig. 1). Sediment phase bioassays were conducted on composite sediment samples taken from SW-11 and one South Beach station. Comprehensive chemical and munitions analyses were performed on surface water taken from SW-10, SW-11, and SW-12; groundwater from well JF8-3; and sediments taken from SW-11 and South Beach.

2.1 Aqueous Phase Biomonitoring Studies

Aqueous phase bioassays were conducted on marsh surface water samples taken at J-Field SW-10, SW-11, and SW-12 immediately east of the toxic burn pit (TBP) Pushout Area. Aqueous phase bioassays were also conducted on surficial groundwater taken from well JF8-3 (screened depth 15-20 feet). The well was purged one equivalent volume via low-flow pumping before each sample was taken (APG, 1995). Three different samples were taken from SW-10, SW-11, and SW-12 and well JF8-3 over a 5-d period. Samples were taken from SW-11 and SW-12 on April 30, May 2, and May 5, 1997. Samples were taken from SW-10 and well JF8-3 on May 2, 5, and 7, 1997.

The following toxicity tests were conducted: 96-h algal (Selenastrum capricornutum) growth test; 7-d cladoceran (Ceriodaphnia dubia) survival and reproduction test; and 7-d fathead minnow (Pimephales promelas) survival and growth test. In addition, developmental toxicity was determined by the 96-h frog embryo teratogenesis assay-Xenopus (FETAX) using the African clawed frog, Xenopus laevis. The experimental procedures for each assay are described below.

2.1.1 Acute Toxicity Tests

Acute toxicity values were calculated where possible for the cladoceran and fathead minnow from the data obtained during the short-term chronic tests described in Section 2.1.2. Forty-eight-h LC50s and 96-h LC50s were determined where possible for the cladoceran and fathead minnow, respectively. With regard to the green alga, EPA's Toxic Substance Control Act office considers the 96-h test to be an acute test (U.S. EPA, 1985 and 1986a). EPA's Office of Research and Development considers the 96-h algal test for growth to be a short-term chronic test for determining the toxicity of effluents (Horning and Weber, 1985; Weber et al., 1989; Lewis et al., 1994) as do other investigators for evaluating single chemicals (for ex., see Hughes et al., 1988

and Suter, 1993). Because we used the short-term chronic test method (Section 2.1.2), we analyzed the data as chronic data.

2.1.2 Short-term Chronic Toxicity Tests

2.1.2.1 Green Alga

The short-term chronic toxicity of the marsh surface water and groundwater to the green alga (S. capricornutum) was determined by the EPA procedures given in Lewis et al. (1994). Stock algal cultures were reared in 2.5 L Pyrex culture flasks containing 1 L of sterilized algal assay medium. Cultures were maintained in a constant temperature incubator under constant cool-white fluorescent lights (≈300 foot candles) at a temperature of 25 ± 0.2°C on a shaker table oscillating at 100 rpm (± 10 %). Log growth cells were used to start all tests.

Algal test solutions were prepared by dilution of the aqueous media with filtered sterilized assay media. Test solutions (100 mL total volume) were dispensed into 250 mL Delong flasks and inoculated with S. capricornutum cells in log growth to achieve a density of ≈1 x 10^4 cells/mL. Triplicates were prepared for each treatment. The flasks were placed on a shaker table in an incubator set at the culturing conditions described above. Growth measurements (cell density) were made from all replicates in each treatment at 96 h. Algal cell density was determined from a 1 mL sample with a Model ZBI Coulter Counter (Coulter Electronics, Inc., Hialeah, Florida). The instrument was calibrated with each use via hemocytometer counts. Test solutions were not renewed during the 96-h studies. pH was not measured at 24-h intervals as recommended by the test procedure.

2.1.2.2 Cladoceran

The chronic toxicity of the marsh surface water and groundwater to C. dubia was determined by the EPA static renewal method (solutions renewed daily) given in Lewis et al. (1994). The cladoceran was cultured at 25 ± 1°C in 600 mL glass beakers filled with 400 mL of 20% Perrier:80% reverse osmosis water amended with selenium (2 μg Se/L as Na_2SeO_3) as recommended by Winner (1989). The diet consisted of a mixture of Cerophyl® (Cerophyl Laboratories, Inc., Kansas City, Missouri) and the green alga, S. capricornutum, added to the cladoceran culture to achieve final concentrations of 120 μg Cerophyl®/mL and ≈6.7 x 10^5 S. capricornutum cells/mL.

All neonates used in the 7-d survival and reproduction tests were produced by cladocerans in culture that had released at least three broods. The initial age of the neonates in each test was <4 h old. The tests were conducted in 50 mL glass beakers containing 25 mL of test solution. All tests were conducted in an environmental chamber at 25 ± 1°C under a 16-h light:8-h dark

photoperiod (fluorescent lights; 60-85 foot candles at the surface of the culture vessels). All test organisms were fed daily as described above at each 24-h renewal. Routine water quality was taken at the beginning and end of each 24-h renewal.

2.1.2.3 Fathead Minnow

The toxicity of the marsh surface water and groundwater to fathead minnows (P. promelas) was determined by the EPA static renewal method (solutions renewed daily) given in Lewis et al. (1994). All larvae used in the 7-d survival and growth tests were <24 h old at the start of the test. The tests were conducted in 600 mL glass beakers containing 400 mL of test solution. The dilution water was a 20% Perrier:80% reverse osmosis water. All test organisms were fed brine shrimp (Artemia sp.) nauplii <24 h old daily at each 24-h renewal. All tests were conducted at 25 ± 1°C under a 16-h light:8-h dark photoperiod (fluorescent lights; 60-85 foot candles). Routine water chemistry was performed at the beginning and end of each renewal. Dry weight was determined by drying at 100°C for a minimum of 12 h.

Fathead minnow larvae were obtained from the UMD/WREC culture maintained at 25 ± 1°C in UMD/WREC non-chlorinated well water (mean dissolved oxygen = 8.1; conductivity = 159 µs/cm; alkalinity = 54 mg/L as $CaCO_3$; hardness = 52 mg/L as $CaCO_3$; pH ranged from 7.1 to 8.0). The UMD/WREC culture procedures were similar to those recommended by Peltier and Weber (1985).

Spawning fish were cultured in fiberglass tanks (2.4 x 0.8 x 0.5 m) containing 0.2 m UMD/WREC well water held at 25 ± 1°C. The spawning adults were fed a diet of frozen brine shrimp (Artemia sp.; Argent Chem. Lab., Redmond, Washington) and TetraMin® Staple Food (Ramfab Aquarium Products Co., Oak Ridge, Tennessee) twice daily. Excess food was removed daily. Four sets of spawning fathead minnows were maintained in the culture tanks at a ratio of 1 male:4 females. Replacement spawners were rotated at approximately three-month intervals. Fathead minnow embryos were collected on spawning substrates (10 cm I.D. x 20 cm long PVC pipe sections cut longitudinally in equal portions) and transferred to 19 L aquaria at 25 ± 1°C in UMD/WREC well water for hatching. All stages of the fish were reared under a 16-h light:8-h dark photoperiod (fluorescent lights; 60-85 foot candles).

2.1.2.4 Developmental Toxicity Test

Developmental toxicity tests were conducted on marsh surface water and groundwater using the frog embryo teratogenesis assay - Xenopus (FETAX). The assay is a 96-h quantitative developmental assay used to screen for developmental toxicants in aquatic media. The assays were conducted using the static renewal

(solutions renewed every 24 h) test method Designation E 1439-91 of the American Society for Testing and Materials (ASTM, 1992). Embryolethality and malformations were determined; growth retardation was not evaluated. The identification and interpretation of malformations in the embryos at 96 h were made via the atlas of Bantle et al. (1991). Aliquots of the marsh surface water and groundwater used for the acute and short-term chronic toxicity biomonitoring tests were used for the FETAX assays.

Embryos between normal stage 8 blastulae and normal stage 11 gastrulae were obtained from X. laevis breeding colonies at the UMD/WREC as described below. The embryos were de-jellied in a 2% L-cysteine solution (2 g of L-cysteine per 98 mL of FETAX solution). Once de-jellied, the embryos were rinsed and re-suspended in FETAX solution (ASTM, 1992). The embryos were tested in glass petri dishes containing 10 mL of solution. Two replicates of 25 embryos/replicate were used for each test treatment. The tests were conducted at 24 ± 0.2°C under a 16-h light: 8-h dark photoperiod (fluorescent lights; ≈75 foot candles at the surface of the test medium) in a constant temperature environmental chamber.

The UMD/WREC X. laevis adult colony was maintained in flow-through (≈4 replacement volumes per day) circular polyethylene aquaria (0.91 m I.D. x 0.36 m high) with a water depth of 10 cm. Each aquarium contained a maximum of 10 adults. UMD/WREC non-chlorinated deep well water (water quality given in Section 2.1.2.3) held at 23.5 ± 0.5 °C served as the culture medium. All frogs were fed every 5-6 d with commercial beef liver supplemented with liquid vitamins (PolyViSol; Mead-Johnson Nutritionals, Evansville, Indiana). The colony was held under a photoperiod of 16 h light:8 h dark. Mating pairs were bred in the dark in 23.5 ± 0.5 °C UMD/WREC non-chlorinated water at ≈70 d intervals by injecting 400 and 800 I.U. of human chorionic gonadotropin (HCG) in the dorsal lymph sac of the males and females, respectively. Amplexus occurred 4-6 h after injecting HCG; egg deposition occurred 9-12 h following HCG injection.

2.2 Sediment Phase Biomonitoring Studies

Sediment phase bioassays were conducted on a composite sediment sample taken from SW-11 and South Beach. The South Beach sample was taken ≈1000 feet east of Rickett's Point Road due south of the TBP area approximately 50 feet off shore (<3 feet deep MSL). The sediment sample from SW-11 was taken on May 7, 1997. The South Beach sediment sample, which was originally scheduled for May 7, 1997, but had to be delayed because on wind-driven high tides, was taken on May 14, 1997. Sediments were collected from the surface to <10 cm with a stainless steel scoop. At each site, the entire contents of 20 to 30 grabs were placed in a pre-cleaned stainless steel bowl and stirred with a

stainless steel spoon until homogeneous in texture and color. Large pieces of debris were discarded. The grab sampler, stainless steel bowl and mixing utensils were rinsed sequentially in methanol, deionized water and ambient water prior to sampling both station.

Twenty-eight day partial life cycle sediment toxicity tests with the amphipod Hyalella azteca were initiated on day 7 and day 14 after sediment collection at SW-11 and South Beach, respectively. The bioassays generally followed the procedures of Ingersoll and Nelson (1990). Briefly, the following experimental conditions were used. The day before the tests were initiated, sediments from SW-11, South Beach, and UMD/WREC Magothy River control sediment were stirred and a 200 mL sub-sample was added to each of five 1 L glass exposure beakers. The sediment was settled by smoothing with a stainless steel spoon followed by the addition of 800 mL of filtered estuarine water which had been diluted with non-chlorinated deep well water to a salinity of <0.5 ppt. Cover glasses were placed on the beakers and aeration from an oil-free compressor was started at the rate of 1-2 bubbles/sec through a 1 mL glass pipette. The test systems were allowed to equilibrate in a constant temperature water bath at 25 (± 1.0) °C for 24 h before the addition of organisms. The photoperiod for all tests was 16:8 h light:dark (fluorescent lights; 60-85 foot candles).

The organisms used in the tests were obtained from an in-house culture. H. azteca were cultured via the methods given in U.S. EPA (1994a). The organisms were acclimated to 25 (± 1.0) °C; <0.5 ppt salinity; and held under a 16:8 h light:dark photoperiod (fluorescent lights; 60-85 foot candles).

All tests were started by introducing 20 juvenile H. azteca (5-10 d old) to each of the five replicate 1 L beakers per treatment. Overlying water quality was monitored throughout the 28-d period as follows: temperature and dissolved oxygen were measured in one of the five beakers daily; pH and conductivity were measured in alternate beakers three times per week. One-half of the overlying water (≈400 mL) in each beaker was renewed three times per week throughout the study. H. azteca were fed a yeast Cerophyl trout chow mixture (YCT) three times per week at the rates of 3.0 mL for days 1-14 and 5.0 mL for days 15-28.

At the end of the experimental period, the amphipods were retrieved in a five-step method described by Ingersoll and Nelson (1990). Briefly, approximately 500 mL of overlying water were poured through a 500 μm sieve cup; the remaining water was swirled to suspend the upper 1 cm of sediment. The suspension was poured through the sieve cup while the remaining sediment was wet sieved through a 500 μm sieve. All contents remaining on the sieves were preserved in vials with 70% ethanol and stained with rose bengal for subsequent enumeration of males, females, and

gravid females.

2.3 Chemical Analyses

Comprehensive chemical analyses and munitions analyses were performed on surface water taken from SW-10, SW-11, and W-12; groundwater from well JF8-3; and sediment taken from SW-11 and South Beach. The analyses were performed on all aqueous phase grab samples and a composite sediment sample from SW-11 taken on May 7, 1997; South Beach sediment (composite sample) was taken on May 14, 1997. The munitions analyses were run on grab samples taken on May 14, 1997, from the aqueous phase media and composite sediment samples.

The comprehensive chemical analyses included general water chemistry, metals, volatile organics, base neutrals, acid compounds, pesticides/PCBs, and herbicides. The elements and/or compounds analyzed in each group, detection limits, analytical methods, etc., are given in the Appendices discussed in Section 3. The munitions analyses included the following: 1) octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX); 2) hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX); 3) 1,3,5-trinitrobenzene (TNB); 4) 1,3-dinitrobenzene (1,3-DNB); 5) N,2,4,6-tetranitro-N-methylaniline (tetryl); 6) nitrobenzene (NB) 7) trinitrotoluene (TNT); 8) 2-amino-4,6-dinitrotoluene (2-AM-4,6-DNT); 9) 4-amino-4,6-dinitrotoluene (4-AM-4,6-DNT); 10) 2,4-dinitrotoluene (2,4-DNT)); 11) 2,6-dinitro-toluene (2,6-DNT); 12) 2-nitrotoluene (2-NT); 13) 3-nitrotoluene (3-NT); and 14) 4-nitrotoluene (4-NT).

All field samples were placed in appropriate containers provided by the vendors for the various analyses. The containers were placed on ice and delivered to the vendors on the morning the samples were taken for the analyses. The comprehensive chemical analyses were performed by Gascoyne Laboratories, Inc., Baltimore, Maryland. The munitions samples were analyzed by U.S. Army Center for Environmental Health Research (USACEHR, 1993).

2.4 Test Endpoints and Data Analyses

The test endpoint for the chronic effects of groundwater to the green alga was growth, measured as density (cells/mL). The 96-h EC50s for growth were estimated by using the "inhibition proportion" technique recommended by Horning and Weber (1985). The technique uses quantal analyses (e.g., probit or moving average angle methods) to estimate EC50s and their 95% fiducial or confidence limits. Since the assumptions of the quantal analysis are not met in the classical sense because of the very nature of the growth data, the count data at each treatment were averaged and subsequently converted to "inhibition proportions" using the formula below before analysis by the Trimmed Spearman-Karber method (U.S. EPA, 1986b).

$$I = C - T / C * 100$$

where: C = the mean growth of the controls
T = the mean growth at a given treatment

The test endpoint for the 48-h and 7-d LC50 tests with cladocerans and 96-h and 7-d LC50 tests with fathead minnows was mortality. The LC50s and their 95% confidence limits were determined by the Trimmed Spearman-Karber method when toxicity >50% occurred (U.S. EPA, 1986b). The 96-h EC50s and their 95% confidence limits for embryo malformations in the FETAX assays were also determined by the Trimmed Spearman-Karber method when malformations >50% occurred (U.S. EPA, 1986b).

The no-observed-effect concentrations (NOEC) and lowest-observed-effect concentrations (LOEC) for alga growth (density as cells/mL) were determined by Dunnett's test. Dunnett's test consists of an analysis of variance (ANOVA) to determine the error term, which is then used in a multiple comparison test for comparing each of the treatment means with the control mean. The assumptions upon which the use of Dunnett's test are contingent are that the observations within treatments are independent and normally distributed, with homogeneity of variance. Shapiro-Wilk's test for normality and Bartlett's test for homogeneity of variances were performed before the Dunnett's test was used. The above statistical tests were performed using Toxstat (WEST, Inc., 1994) at a minimum probability level of 0.05.

The endpoints for the 7-d survival and reproduction tests with the cladoceran were survival and young production. The endpoints for the fathead minnow 7-d survival and growth tests were survival and growth. The endpoints for the 96-h FETAX assay were survival and number of malformations. The statistics used for the LC50 data and FETAX EC50 (malformations) data are given above. NOECs and LOECs were determined as follows. The adult raw cladoceran survival data were analyzed by Fisher's Exact test. Arc-sine square root transformations were made on the fathead minnow percent survival data and the FETAX percent embryo survival and percent embryo malformation data before further data analyses were performed. With the exception of the cladoceran survival data, all data were then subjected to Shapiro-Wilk's test for normality and Bartlett's test for homogeneity of variance.

When the data sets met the assumptions of normality and homogeneity of variance, a parametric statistic was used. Dunnett's test was used when the number of replicates was constant among treatments. When a data set failed to meet the assumptions of normality or homogeneity of variance, Steel's Many-One Rank test was performed. The statistical tests were performed using Toxstat (WEST, Inc., 1994). A minimum

probability level of 0.05 was used for all tests.

The endpoints for the 28-d amphipod sediment tests were survival, growth (as estimated by length from the base of the first antennae to the tip of the third uropod along the curve of the dorsal surface) and sexual maturation (proportion of gravid females). All data were evaluated for normality and homogeneity of variance using the Shapiro-Wilk's test and Bartlett's test, respectively. The mortality and reproduction data were subjected to arc sine square root transformation in order to meet the homogeneity of variance assumption. An analysis of variance was conducted on the mortality and growth data. A Steel's Many-One Rank Test was used for the reproduction data because the variances were not homogenous. The statistical tests were performed using Toxstat (WEST, Inc., 1994). A minimum probability level of 0.05 was used for all tests.

SECTION 3

RESULTS AND DISCUSSION

The Results and Discussion Section is organized as follows. The biomonitoring and chemical data are presented for each sample site. The results of all the biomonitoring toxicity test are summarized in Table 1. The raw data, water quality data, and statistical analyses for the biomonitoring tests as well as the chemical analyses results are given in separate Appendices as referred to in the appropriate sections for each site.

A number of aquatic toxicological studies in various media were conducted at J-Field during the spring of 1994 (April, May, and June) under the direction of Argonne National Laboratory (Hayse, 1995) and in June 1995 by EnviroSystem, Inc. (ESI, 1995a-c). A comparison of the results obtained in the present study with those reported by Argonne National Laboratory for SW-10, SW-11, SW-12, and well JF8-3 and EnviroSystem, Inc. for SW-10, SW-11, and SW-12 is tabulated in Tables 2-5. Sediment data from various studies at South Beach are also presented below.

3.1 SW-10 Aqueous Phase Tests

Surface water from SW-10 (Fig. 1) was toxic to the green alga (Table 1). The 96-EC50 (reduction in cell density) was 80% surface water by volume; the NOEC and LOEC (reduction in cell density) were 18% and 32% surface water by volume, respectively. The surface water was not acutely or chronically toxic to the cladoceran. SW-10 water was not acutely toxic to the fathead minnow; the water did cause chronic toxicity. The fathead minnow NOEC and LOEC (reduction in growth) were 18% an 32% surface water by volume. SW-10 surface water did not affect survival in the frog embryo assay. However, significant malformations occurred relative to the controls. The NOEC and LOEC for malformations were 100% and 56% surface water by volume. The alga, cladoceran, fathead minnow, and FETAX test data for SW-10 are given in Appendices 1, 2, 3, and 4, respectively.

A comparison of the toxicity results obtained in the current study with those reported by Argonne National Laboratory (Hayse, 1995) and EnvironSystem, Inc. (ESI, 1992a) for SW-10 is given in Table 2. As was the case in the current study, Argonne National Laboratory reported that a 96-h screening assay conducted in April 1994 was toxic to the same species of green alga used in the current study. The surface water was not acutely or chronically toxic to the cladoceran C. dubia in the current study. EnvironSystem, Inc, (1995a) also found in their June 1995 study that the surface water did not cause chronic toxicity to C. dubia. Argonne National Laboratory found that surface water from SW-10 was not toxic to the cladoceran Daphnia magna in two acute

screening tests conducted in April and May 1994 and an acute definitive 48-h test conducted in May 1994.

Similar to the present study, Argonne National Laboratory found that the surface water was not acutely toxic during a screening test to the fathead minnow. As in the current study, Argonne National Laboratory also found that the surface water caused chronic toxicity to the fathead minnow. The chronic NOEC and LOEC (reduction in growth) found in the current study were 18% and 32% surface water by volume. Argonne National Laboratory reported a NOEC and LOEC (reduction in survival) of 25% and 50% surface water by volume for the fathead minnow.

Surface water from SW-10 did not cause a reduction in survival during the 96-h test conducted by the University of Maryland to embryos of the African clawed frog (X. laevis); significant malformations were found in the embryos after a 96-h exposure. Argonne National Laboratory also found that the surface water was not toxic during a 48-h screening test to young southern leopard frogs (Rana sphenocephala) which were <14 d old at the start of the test. Argonne National Laboratory reported (pp. 7 and 10 in Vol. 1; Hayse, 1994) that acute definitive tests were also run with the southern leopard frog at SW-10 in May 1994; however, we could not find the results of the assays.

A 10-d acute sediment test with an amphipod (H. azteca) conducted by Argonne National Laboratory was negative for surficial sediment taken from SW-10; EnvironSystem, Inc. (1995a) conducted a 28-d chronic test with the same amphipod and did not find the sediment to be toxic. A sediment test at SW-10 was not conducted in the current study.

Vinyl chloride, trans-1,2-dichloroethene, 1,1,2-trichloroethane, 1,1,2,2-tetrachloroethane, and trichloroethene were found in SW-10 surface water at the concentrations listed in Appendix 18. No priority pollutant base neutrals, acid compounds, pesticides/PCBs, or herbicides were found at the detection limits given in Appendix 18. With the exception of aluminum, no priority pollutant heavy metals were found above the detection limits given in Appendix 18. None of the munitions listed in Section 2.3 were detected at a quantitation limit of 50 µg/L (Appendix 18).

Argonne National Laboratory (ANL, 1995) found four of the above five volatile organics at SW-10 during studies in April 1993, February 1994, and May 1994. Vinyl chloride was not found at a detection limit of 62 µg/L in the April 1993 study; a concentration of 57 µg/L was found in the current study (Appendix 18). A concentration of 26 µg/L was reported in the February 1993 and May 1994 study. The concentrations of the remaining volatiles reported in the Argonne National Laboratory studies were approximately an order of magnitude or higher than the

were approximately an order of magnitude or higher than the concentrations found in the current study. Argonne National Laboratory also reported the presence of tetrachloroethene at an estimated concentration of 44 µg/L in April 1993 and estimated concentrations of 5 and 3 µg/L for 1,1-dichloroethene in the February 1993 and May 1994 studies. Tetrachloroethene and 1,1-dichloroethene were not detected in the current study at 5 µg/L.

N-Nitrosodiphenylamine (2 µg/L estimated concentration) was the only semivolatile organic reported for the April 1993 study by Argonne National Laboratory (ANL, 1995). No other semivolatile organics were found in either the April 1993 or May 1994 study. Likewise, no pesticides or PCBs were found in the April 1993 or May 1994 study at SW-10.

With the exception of aluminum, no priority pollutant heavy metals were found in the current study at the detection limits given in Appendix 18. Zinc was the only priority pollutant heavy metal reported by Argonne National Laboratory (ANL, 1995) during a September 1993 study at SW-10. Zinc was found at a concentration of 21.5 µg/L in 1993. No zinc was found in 1997 at a detection limit of 20 µg/L. Aluminum (226 µg/L) and lead (6.5 µg/L) were reported for SW-10 surface water in the May 1994 study. A concentration of 300 µg/L aluminum was found in the current study (Appendix 18).

3.2 SW-11 Aqueous Phase Tests

Surface water from SW-11 was toxic to the green alga. The 96-EC50 for reduction in cell density was 51% surface water by volume; the NOEC and LOEC (reduction in cell density) were 18% and 32% surface water by volume, respectively (Table 1). The water was not acutely or chronically toxic to the cladoceran. SW-11 water caused both acute and chronic toxicity to the fathead minnow. The 96-h and 7-d LC50s were 47% and 40% surface water by volume, respectively. The fathead minnow NOEC and LOEC (mortality) were 18% and 32% surface water by volume. SW-11 surface water did not cause any mortality to frog embryos. However, significant malformations occurred. The NOEC and LOEC for malformations were 32% and 56% surface water by volume. The alga, cladoceran, fathead minnow, FETAX, and amphipod test data for SW-11 are given in Appendices 5, 6, 7, and 8 respectively.

As was the case in the current study, Argonne National Laboratory (Hayse, 1995) reported that a 96-h screening assay was toxic to the same green alga at SW-11 (Table 3). The surface water was not acutely or chronically toxic to the cladoceran C. dubia in the current study. Argonne National Laboratory also found that surface water from SW-11 was not toxic to the cladoceran D. magna in an acute 48-h screening test conducted in April 1994. Likewise, EnviroSystem, Inc. (ESI, 1995b) found that the surface water did not cause chronic toxicity to C. dubia.

Argonne National Laboratory found that the surface water at SW-11 was not acutely toxic to the fathead minnow during a 48-h screening test (Table 3). The University of Maryland found that the surface was toxic to the fathead minnow in an acute definitive 96-h test. The water also caused chronic toxicity to the fish in the current study; Argonne National Laboratory reported the SW-11 surface water was not chronically toxic to the fathead minnow (Hayse, 1995).

Surface water from SW-11 did not cause a reduction in survival for frog embryos during the 96-h test conducted by the University of Maryland; significant malformations were found in the embryos after a 96-h exposure. Argonne National Laboratory also found that the surface water was not toxic to young southern leopard frogs (<14 d old) during a 48-h screening test.

No priority pollutant volatile organics, base neutrals, acid compounds, pesticides/PCBs, or herbicides were found in the surface water at SW-11 at the detection limits listed in Appendix 19. Argonne National Laboratory (ANL, 1995) found 16 µg/L 1,2-dichloroethene (total) in SW-11 surface waters in April 1993; none was found at a detection limit of 5 µg/L in the current study (Appendix 19). Argonne National Laboratory also reported four other volatile organics which had estimated concentrations near or below the detection limits of the current study. With the exception of N-nitrosodiphenylamine (2 µg/L estimated concentration), Argonne National Laboratory (ANL, 1995) did not report any other semivolatile organics, pesticides, or PCBs. None of the 14 munitions listed in Section 2.3 were detected at a quantitation limit of 50 µg/L for the surface water (Appendix 19).

Aluminum, copper, and zinc were found in SW-11 surface water at the concentrations given in Appendix 19. Argonne National Laboratory (ANL, 1995) reported a number of priority pollutant heavy metals in surface water at SW-11 in May 1994. The metals included aluminum, arsenic, chromium, copper, lead, mercury, and zinc. The concentrations of aluminum, copper, and zinc reported by Argonne National Laboratory were an order of magnitude higher in May 1994 than in May 1997.

3.3 SW-11 Sediment Test

Surficial sediment taken from SW-11 was not toxic to the amphipod during a 28-d chronic exposure (Table 1; Appendix 17). EnviroSystem, Inc. (ESI, 1995b) conducted a 28-d sediment test in June 1995 with the same amphipod used in the current study and found a significant reduction in growth (both length and weight) (Table 3). Argonne National Laboratory found that sediments from the same site were not toxic in a 10-d acute test to the same species of amphipod (Hayse, 1995).

No priority pollutant volatile organics, acid compounds, pesticides/PCBs, or herbicides were found in SW-11 sediments at the detection limits listed in Appendix 20. With the exception of di-n-butyl phthalate (see comment in Sect. 3.6), no other base/neutral compounds were found in the surficial sediment. Argonne National Laboratory reported 4,4'-DDD and 4,4'-DDE concentrations of 11 and 7 μg/kg, respectively, in the surficial sediments at SW-11 in a June 1995 study (Yuen et al., 1996). 4,4'-DDD and 4,4'-DDE were not found in the current study at detection limits of 0.5 and 1.4 mg/kg, respectively. None of the 14 munitions listed in Section 2.3 were detected at a quantitation limit of 0.5 μg/g dry weight for the sediment sample (Appendix 20).

The surficial sediment from SW-11 contained high (relative to surface water) concentrations of a number of heavy metals (Appendix 20). Argonne National Laboratory (Yuen et al., 1996) also found high concentrations of heavy metals in the sediment from SW-11 during their June 1995 study. The following heavy metals were found in 1995 and 1997: aluminum- not measured in 1995 (?) vs 14,000 mg/kg in 1997; antimony- 11 mg/kg in 1995 vs <120 mg/kg detection limit in 1997; arsenic- 14 mg/kg vs <120 mg/kg detection limit; barium- 269 mg/kg vs not measured in 1997; cadmium- not elevated above background in 1995 vs 5 mg/kg in 1997; chromium- 46 vs 99 mg/kg; copper- 209 vs 590 mg/kg; lead- 1,260 vs 2,500 mg/kg; mercury- 0.8 vs 1.5 mg/kg; nickel- not measured in 1995 (?) vs 29 mg/kg in 1997; silver- 1.3 vs 5 mg/kg; and zinc- 1,410 vs 2,200 mg/kg.

3.4 SW-12 Aqueous Phase Tests

As was the case for SW-10 and SW-11, surface water from SW-12 was also toxic to the green alga. The 96-EC50 (reduction in cell density) was 79% surface water by volume; the NOEC and LOEC (reduction in cell density) were 10% and 18% surface water by volume, respectively (Table 1). The surface water was not acutely toxic to the cladoceran; chronic toxicity did occur to the cladoceran. The NOEC and LOEC were 18% and 32% surface water by volume. SW-12 surface water was not acutely toxic to the fathead minnow; the water did cause chronic toxicity. The 7-d LC50 for the fathead minnow was 91% surface water by volume; the NOEC and LOEC (mortality) were 18% an 32% surface water by volume. SW-12 surface water did not cause any mortality to frog embryos; however, significant malformations occurred. The NOEC and LOEC for malformations were 32% and 56% surface water by volume. The bioassay test data for SW-12 are given in Appendices 9-12, respectively.

Surface water from SW-12 was found to be toxic to the green alga in both the University of Maryland and Argonne National Laboratory study (Table 4). The surface water did not cause significant acute mortality to the cladoceran (C. dubia) in the

current study. Likewise, Argonne National Laboratory also found that surface water from SW-12 was not toxic to D. magna in an acute 48-h screening test. A significant reduction in reproduction was found, however, for C. dubia during the chronic test in the University of Maryland study. In contrast, EnviroSystem, Inc. (ESI, 1995c) did not detect any chronic toxicity to C. dubia in a 1995 study.

SW-12 surface water was not acutely toxic to the fathead minnow in the University of Maryland or the 1994 Argonne National Laboratory study (Table 4). Chronic toxicity was found in the current study but not in the Argonne National Laboratory chronic study. Surface water from SW-12 did not cause a reduction in survival for frog embryos during the 96-h test conducted by the University of Maryland or a 48-h screening test conducted with southern leopard frogs by Argonne National Laboratory. Significant malformations, however, were found by the University of Maryland for frog embryos exposed for 96-h to SW-12 surface water.

Argonne National Laboratory found that sediments from SW-12 were toxic to the amphipod during a 10-d acute test. In contrast, EnviroSystem, Inc. (ESI, 1995c) did not find sediments from SW-12 to be toxic to the amphipod is a 28-d chronic test. A sediment test was not run at SW-12 during the current study.

No priority pollutant volatile organics, base neutrals, acid compounds, pesticides/PCBs, or herbicides were found at SW-12 at the detection limits listed in Appendix 21. With the exception of acetone (8 µg/L estimated concentration) and N-nitroso-diphenylamine (2 µg/L estimated concentration), Argonne National Laboratory (ANL, 1995) did not find any other volatile organics or semivolatile organics, respectively, in an April 1993 study. Likewise, no pesticides or PCBs were found in the April 1993 study. None of the 14 munitions listed in Section 2.3 were detected at a quantitation limit of 50 µg/L (Appendix 21).

Aluminum, copper, lead, and zinc were found in SW-12 surface water in the current study (Appendix 21). Argonne National Laboratory (ANL, 1995) found aluminum, arsenic, barium, copper, lead, and zinc in surface water at SW-12 in May 1994. With the exception of lead which had a higher concentration in 1997 (200 µg/L) than in 1994 (169 µg/L), aluminum (731 µg/L in 1994 vs 400 µg/L in 1997), copper (105 µg/L in 1994 vs 50 µg/L in 1997), and zinc (968 µg/L in 1994 vs 630 µg/L in 1997) were higher in 1994 than 1997.

3.5 Well JF8-3 Aqueous Phase Tests

Groundwater from well JF8-3 was toxic to all organisms. The alga 96-EC50 (reduction in cell density) was 39% groundwater by volume; the NOEC and LOEC (reduction in cell density) were 10%

and 18% groundwater by volume, respectively (Table 1). The cladoceran 48-h and 7-d LC50s were 40% and 36% groundwater by volume, respectively. The cladoceran NOEC and LOEC (reduction in neonate production) were 10% and 18% groundwater by volume. The fathead minnow 96-h and 7-d LC50s were both 13% groundwater by volume. The fathead minnow NOEC and LOEC (mortality) were 10% an 18% groundwater by volume.

Frog embryo mortality occurred; however, an LC50 could not be determined because <50% mortality occurred. Significant malformations occurred. The 96-EC50 for malformations was 52% groundwater by volume. The NOEC and LOEC for malformations were 18% and 32% groundwater by volume. The test data for well JF8-3 are given in Appendices 13, 14, 15, and 16, respectively.

Argonne National Laboratory also found the groundwater to be acutely toxic to the green alga, cladoceran (D. magna), fathead minnow, and southern leopard frog (Table 5).

Well JF8-3 contained several volatile organics (see below; Appendix 22). Hexachloroethane (base/neutral) was also reported for the groundwater sample. No priority pollutant acid compounds, pesticides/PCBs, or herbicides were found in the well at the detection limits listed in Appendix 22. No priority pollutant heavy metals were reported for the well at the detection limits listed in Appendix 22. None of the munitions listed in Section 2.3 were detected at a quantitation limit of 50 µg/L (Appendix 22).

The volatile organics found in the current study were also reported by Argonne National Laboratory in their May 1994 study (ANL, 1995). The concentrations between the two studies are very similar. The following volatile organics were found in 1994 and 1997: vinyl chloride- 34 µg/L in 1994 vs 13 µg/L in 1997; 1,2-dichloroethene- 4,100 µg/L estimated in 1994 vs 1,800 µg/L estimated in 1997; chloroform- 44 vs 36 µg/L; 1,2-dichloroethane- 6 µg/L estimated in 1994 vs <5 µg/L in 1997; carbon tetrachloride- 6 µg/L estimated in 1994 vs 5 µg/L; 1,1,2-trichloroethane- >990 in 1994 vs 1,700 µg/L estimated in 1997; tetrachloroethene- >1,100 vs 2,300 µg/L estimated in 1997; 1,1,2,2-tetrachloroethane- 160,000 vs 130,000 µg/L estimated in 1997; 1,1-dichloroethene- 12 vs 10 µg/L; trichloroethene- 21,000 vs 32,000 µg/L estimated in 1997; and benzene- 6 estimated in 1994 vs 5 µg/L.

Argonne National Laboratory (ANL, 1995) reported the following semivolatile compounds in their May 1994 study: 57 µg/L indeno[1,2,3-cd]pyrene and estimated concentrations of 4, 2, and 2 µg/L for 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, and hexachlorocyclopentadiene, respectively. None of the above base/neutral compounds were found in the current study at a detection limit of 10 µg/L. Hexachloroethane was found in the

and 18% groundwater by volume, respectively (Table 1). The cladoceran 48-h and 7-d LC50s were 40% and 36% groundwater by volume, respectively. The cladoceran NOEC and LOEC (reduction in neonate production) were 10% and 18% groundwater by volume. The fathead minnow 96-h and 7-d LC50s were both 13% groundwater by volume. The fathead minnow NOEC and LOEC (mortality) were 10% an 18% groundwater by volume.

Frog embryo mortality occurred; however, an LC50 could not be determined because <50% mortality occurred. Significant malformations occurred. The 96-EC50 for malformations was 52% groundwater by volume. The NOEC and LOEC for malformations were 18% and 32% groundwater by volume. The test data for well JF8-3 are given in Appendices 13, 14, 15, and 16, respectively.

Argonne National Laboratory also found the groundwater to be acutely toxic to the green alga, cladoceran (D. magna), fathead minnow, and southern leopard frog (Table 5).

Well JF8-3 contained several volatile organics (see below; Appendix 22). Hexachloroethane (base/neutral) was also reported for the groundwater sample. No priority pollutant acid compounds, pesticides/PCBs, or herbicides were found in the well at the detection limits listed in Appendix 22. No priority pollutant heavy metals were reported for the well at the detection limits listed in Appendix 22. None of the munitions listed in Section 2.3 were detected at a quantitation limit of 50 µg/L (Appendix 22).

The volatile organics found in the current study were also reported by Argonne National Laboratory in their May 1994 study (ANL, 1995). The concentrations between the two studies are very similar. The following volatile organics were found in 1994 and 1997: vinyl chloride- 34 µg/L in 1994 vs 13 µg/L in 1997; 1,2-dichloroethene- 4,100 µg/L estimated in 1994 vs 1,800 µg/L estimated in 1997; chloroform- 44 vs 36 µg/L; 1,2-dichloroethane- 6 µg/L estimated in 1994 vs <5 µg/L in 1997; carbon tetrachloride- 6 µg/L estimated in 1994 vs 5 µg/L; 1,1,2-trichloroethane- >990 in 1994 vs 1,700 µg/L estimated in 1997; tetrachloroethene- >1,100 vs 2,300 µg/L estimated in 1997; 1,1,2,2-tetrachloroethane- 160,000 vs 130,000 µg/L estimated in 1997; 1,1-dichloroethene- 12 vs 10 µg/L; trichloroethene- 21,000 vs 32,000 µg/L estimated in 1997; and benzene- 6 estimated in 1994 vs 5 µg/L.

Argonne National Laboratory (ANL, 1995) reported the following semivolatile compounds in their May 1994 study: 57 µg/L indeno[1,2,3-cd]pyrene and estimated concentrations of 4, 2, and 2 µg/L for 1,2,4-trichlorobenzene, 1,2-dichlorobenzene, and hexachlorocyclopentadiene, respectively. None of the above base/neutral compounds were found in the current study at a detection limit of 10 µg/L. Hexachloroethane was found in the

current study at a concentration of 97 µg/L; it was not detected by Argonne National Laboratory in 1994 at 10 µg/L.

As was the case in the present study, no pesticides or PCBs were detected by Argonne National Laboratory in their study. With regard to munitions, Argonne National Laboratory detected 8.5 µg/L RDX in well JF8-3; RDX was not found in the current study at a detection limit of 50 µg/L. Total aluminum, arsenic, and zinc were found in well JF8-3 at concentrations of 501, 64, and 26 µg/L in 1994. Aluminum, arsenic, and zinc were not found in 1997 at detection limits of 100, 500, and 20 µg/L, respectively.

3.6 South Beach Sediment Test

The sediment from South Beach was not toxic to the amphipod H. azteca (Table 1). Survival, growth, and reproduction were not affected by 28-d exposures to the sediment. The test data for South Beach are given in Appendix 17. To the authors knowledge, no other 28-d chronic tests have been conducted with sediment taken from the same offshore area at South Beach. ICF Kaiser conducted a number of 28-d sediment toxicity studies during the summer of 1996 (August 28 to September 25) to identify areas of potential concern in the Gunpowder River (Neubauer et al., 1997). ICF Kaiser took six near-field and six intermediate-field samples from the western shore of J-Field which were approximately equi-spaced from Rickett's Point north to Site XI (Fig. 1); no samples were taken from South Beach. No toxicity was detected at any of the 12 stations using the amphipod Leptocheirus plumulosus. A sediment toxicity test was conducted with H. azteca at one of six of ICF Kaiser's near-field stations; toxicity did not occur (Neubauer et al., 1997).

EPA conducted a 10-d toxicity test with the saltwater amphipod Ampelisca abdita on sediment taken in August 1992 from the same general area (EPA location #09) as the current test (U.S. EPA, 1994b). Thirty-five percent of the treatment organisms died during the test in contrast to 6% mortality in the controls. EPA concluded that the higher mortality rate for the treatment group was probably related to habitat preference (i.e., physical sediment variables) rather than potential toxicants bound to organic carbon (U.S. EPA, 1994b). In addition, EPA also ran a 48-h LC50 acute toxicity test with D. magna and 5- and 15-min Microtox assays on leacheate from the sediment sample. The leacheate was not toxic in either test (U.S. EPA, 1994b).

ICF Kaiser conducted screening level bioassays (May to June 1993) on pore water taken from sediment in the same general area (ICF Kaiser stations GPR-117, GPR-119, and GPR-121) as the current chronic test (Neubauer et al., 1996). They found that the sediment pore water was not toxic in the Microtox® assay. Toxicity was detected at one of the three stations (ICF Kaiser

station GPR-117) by the Daphnia magna IQ Test® (Neubauer et al., 1996). There is some question about the toxicity observed in the Daphnia magna IQ Test®. ICF Kaiser concluded that the results of the neither the Microtox® or Daphnia magna IQ Test® correlated well with the compounds detected in the study area; thus, the cause of the stress responses is unclear (Neubauer et al., 1996).

Several heavy metals were reported for the sediment sample taken from South Beach in the current study (Appendix 23). EPA also found several heavy metals in the sediment sample (location #09) used in their August 1992 study (U.S. EPA, 1994b). The following heavy metals were found in 1992 and 1997: aluminum- 5300 mg/kg in 1992 vs 3400 mg/kg in 1997; arsenic- 2 mg/kg in 1992 vs <40 mg/kg in 1997; chromium- 11 mg/kg vs 3 mg/kg; cobalt- 6 mg/kg in 1992 vs 1.3 mg/kg in 1997; copper- 10 mg/kg vs 1.7 mg/kg; lead- 6 mg/kg vs <9 mg/kg; nickel- 10 mg/kg vs 3 mg/kg; and zinc- 30 mg/kg in 1992 vs 7 mg/kg in 1997.

The only organic reported for South Beach in the current study was di-n-butyl phthalate. The di-n-butyl phthalate reported for sediment taken from both South Beach and SW-11 (Sect. 3.2) seems odd. The compound is usually associated with plastic. No plastic devices or containers were used at either site while sampling and shipping the samples. No munitions were found at South Beach at a detection level of 0.5 μg/g dry weight sediment (Appendix 23). No volatiles, semivolatiles, pesticides/PCBs, or munitions were found by EPA in their August 1992 study (U.S. EPA, 1994b).

SECTION 4

CONCLUSIONS

Definitive acute aqueous phase bioassays were conducted with a cladoceran (Ceriodaphnia dubia), fathead minnow (Pimephales promelas), and African clawed frog (Xenopus laevis). The results of the assays were quite consistent with the screening and definitive bioassays conducted in the spring of 1994 with a cladoceran (Daphnia magna), fathead minnow, and southern leopard frog (Rana sphenocephala). Both studies show that the surface waters at the three sites are not acutely toxic to cladocera and frogs. Two of the three sites (SW-10 and SW-12) are not acutely toxic to fathead minnow. The third site (SW-11) was not found to be toxic in the 1994 study during a 48-h screening test; a definitive acute test conducted in 1997 showed that the surface water was toxic to fathead minnow after a 96-h exposure.

Chronic toxicity tests conducted during the spring of 1997 on surface water from the same three sites showed the following. Briefly, both the 1994 and 1997 studies showed that the surface waters at the three marsh sites (SW-10, SW-11, and SW-12) in the vicinity of the TBP Pushout Area are chronically toxic to the green alga (Selenastrum capricornutum). Two of the three sites (SW-10 and SW-11) did not cause any chronic toxicity in 1997 to Ceriodaphnia; SW-12 was toxic during a 7-d exposure. No chronic toxicity to Ceriodaphnia was found at the three sites in a 1995 study.

All three sites caused chronic toxicity to the fathead minnow in 1997. Chronic toxicity was also found in the 1994 study at SW-10; chronic toxicity to the fathead minnow was not found at SW-11 and SW-12 in 1994. As stated above, the marsh surface waters at SW-10, SW-11, and SW-12 were not acutely toxic to frogs. Although the waters from the three sites did not cause significant mortality to frogs, significant increases in frog embryo malformations were found in teratogenic assays at all three sites in 1997.

Surficial sediment taken from SW-11 was not toxic to the amphipod Hyalella azteca during a 28-d chronic exposure in the current study. A 28-d sediment study conducted in 1995 with the same species of amphipod found that SW-11 sediment was toxic (reduction in growth occurred). As in the current study, a 10-d acute sediment test conducted in May 1994 also showed that SW-11 sediment was not toxic to the same amphipod species. Chronic sediment tests run in 1995 showed that sediments from SW-10 and SW-12 were not toxic to amphipods during 28-d exposures. Sediment from SW-12 was found to be toxic to the amphipod in 1994 during a 10-d acute test.

Sediment from South Beach did not cause any chronic toxicity to the amphipod (H. azteca). EPA conducted a 10-d toxicity test with the saltwater amphipod Ampelisca abdita on sediment taken in August 1992 from the same general area as the current test. Although 35% of the treatment organisms died during the test, EPA concluded that the mortality was probably related to habitat preference (i.e., physical sediment variables) rather than potential toxicants bound to organic carbon. Screening level bioassays (May to June 1993) on pore water taken from sediments in the same general area of South Beach have also shown that the sediments are not toxic.

As expected, the contaminated groundwater from the well (JF8-3) up-gradient from the TBP marsh area was found to be acutely and chronically toxic to all organisms tested in 1997. Likewise, the 1994 study also showed that groundwater from the same well caused acute toxicity to the alga, cladoceran, fathead minnow, and frog.

Comprehensive chemical analyses and munitions analyses were performed on surface water taken from SW-10, SW-11, and W-12; groundwater from well JF8-3; and sediments taken from SW-11 and South Beach. The comprehensive chemical analyses included general chemistry, metals, volatile organics, base neutrals, acid compounds, pesticides/PCBs, and herbicides. Nitroaromatics and nitramines were determined in the munitions analyses. The results of the chemical analyses conducted in the current study were very similar to the results reported in prior studies for the three marsh sites, well JF8-3, and South Beach.

In summary, the current supports the toxicological findings of previous studies. With regard to the marsh adjacent to the TBP Pushout Area, earlier studies did not identify toxicity to frogs. The current study found that malformations occurred to frogs at all marsh sites tested in the Pushout Area. Likewise, the current study showed that short-term chronic toxicity occurred to fish at two of three sites that in the past were not found to be chronically toxic to the same species of fish. The present study confirms previous studies that ecological receptors are at risk in the Pushout Area of the marsh.

SECTION 5

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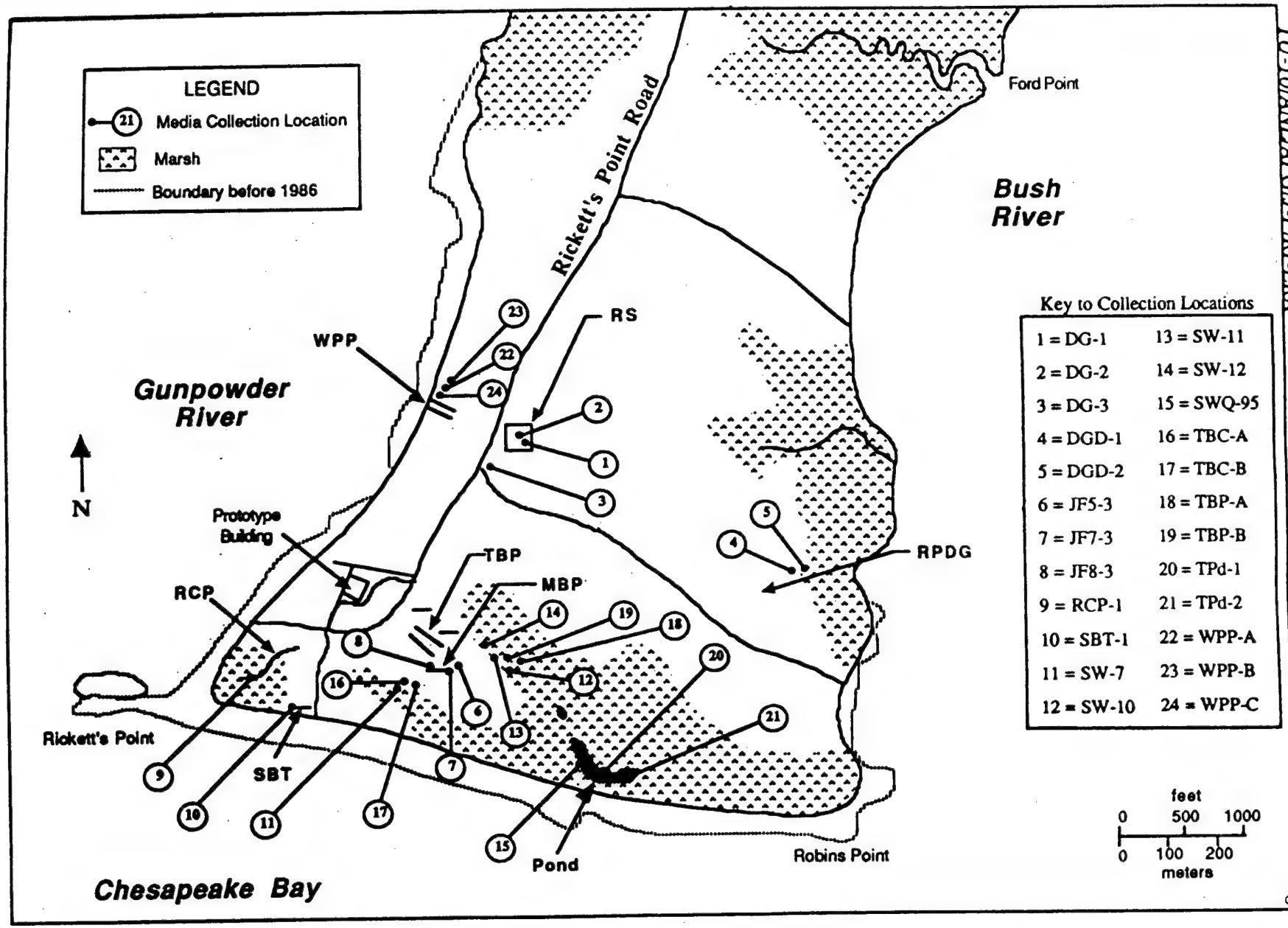

Figure 1. Approximate locations of media collection sites at J-Field, Aberdeen Proving Ground, Maryland. Areas of concern are designated by acronyms: Mustard Burning Pit (MBP), Riot Control Pit (RCP), Robins Point Demolition Ground (RPDG), South Beach Trench (SBT), Toxic Burning Pits (TBP), and White Phosphorus Pits (WPP) (Fig. taken from Argonne National Laboratory 1995 Report No. TU-10/ANL/APG/J-F/RI-ERA).

TABLE 1. SUMMARY OF THE TOXICITY ENDPOINTS FOR THE BIOMONITORING TESTS CONDUCTED ON VARIOUS J-FIELD AQUATIC MEDIA DURING HIGH SURFICIAL AQUIFER FLOW CONDITIONS

Bioassay	Endpoint	Value[a]				
		SW-10	SW-11	SW-12	Well JF8-3	South Beach
Green alga:						
	96-h EC50[b]	80	51	79	39	*[c]
		(73.4-86.6)	(47.4-55.1)	(68.0-91.7)	(35.5-43.0)	*
	NOEC[b]	18	18	10	10	*
	LOEC[b]	32	32	18	18	*
Cladoceran:						
	48-h LC50	Not toxic	Not toxic	Not toxic	40	*
					(30.9-51.7)	*
	7-d LC50	Not toxic	Not toxic	Not toxic	36	*
					(27.3-46.6)	*
	NOEC[d]	Not toxic	Not toxic	18	10	*
	LOEC[d]	Not toxic	Not toxic	32	18	*
Fathead minnow:						
	96-h LC50	No LC50	47	No LC50	13	*
			(41.5-52.0)		(12.3-13.8)	*
	7-d LC50	No LC50	40	91	13	*
			(33.3-49.0)	(54.1-152.4)	(12.0-13.7)	*
	NOEC[e]	18	18	18	10	*
	LOEC[e]	32	32	32	18	*

TABLE 1. (CONTINUED)

Bioassay	Endpoint	Value[a]				
		SW-10	SW-11	SW-12	Well JF8-3	South Beach
FETAX:						
	4-d LC50	Not toxic	Not toxic	Not toxic	No LC50	*
	4-d EC50[f]	No EC50	No EC50	No EC50	52 (44.2-61.1)	*
	NOEC[g]	56	32	32	18	*
	LOEC[g]	100	56	56	32	*
Amphipod:						
	Survival	*	Not toxic	*	*	Not toxic
	Growth	*	Not toxic	*	*	Not toxic
	Reproduction	*	Not toxic	*	*	Not toxic

[a] Endpoints for surface water (SW-10, SW-11, and SW-12) are given as percent surface water by volume; endpoints for groundwater (well JF8-3) are given as percent groundwater by volume; endpoints for sediment do not have volume units.
[b] Test endpoint- reduction in growth (cell density).
[c] * = Not evaluated.
[d] Test endpoint- reduction in neonate production.
[e] Test endpoint- reduction in growth (dry weight) for SW-10; endpoint for SW-11, SW-12, and well JF8-3 is a decrease in survival rather than a reduction in growth.
[f] 96-h EC50 for malformations.
[g] Test endpoint- increased number of malformations for SW-10, SW-11, and SW-12; endpoint for well JF8-3 is a decrease in survival rather than an increase in malformations.

TABLE 2. COMPARISON OF THE TOXICITY RESULTS FOUND IN THE CURRENT STUDY WITH THE RESULTS OF PREVIOUS STUDIES AT SW-10

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994
Green alga:						
	96-h Screen[b]	*[c]	*	93.1[d]	*	*
	96-h EC50[e]	80	*	*	*	*
	NOEC[e]	18	*	*	*	*
	LOEC[e]	32	*	*	*	*
Cladocera:						
Ceriodaphnia	48-h LC50	Not toxic	*	*	*	*
	7-d LC50	Not toxic	Not toxic	*	*	*
	NOEC[f]	Not toxic	Not toxic	*	*	*
	LOEC[f]	Not toxic	Not toxic	*	*	*
Daphnia	48-h Screen	*	*	Not toxic	Not toxic	*
	48-h LC50	*	*	*	Not toxic	*
Fathead minnow:						
	48-h Screen	*	*	Not toxic	*	*
	96-h LC50	No LC50	*	*	*	*
	7-d LC50	No LC50	*	*	*	*
	NOEC	18[g]	*	*	25[h]	*
	LOEC	32[g]	*	*	50[h]	*

TABLE 2. (CONTINUED)

Bioassay	Endpoint	Value[a] UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994
Frogs:						
Xenopus (FETAX)	96-h LC50	Not toxic	*	*	*	*
	96-h EC50[i]	No EC50	*	*	*	*
	NOEC[j]	56	*	*	*	*
	LOEC[j]	100	*	*	*	*
Rana	48-h Screen	*	*	Not toxic	*	*
	48-h LC50	*	*	*	*[k]	*
Amphipod:						
10-d acute	Survival	*	*	*	Not toxic	
	Growth	*	*	*	Not toxic	*
28-d chronic	Survival	*	Not toxic	*	*	*
	Growth	*	Not toxic	*	*	*
	Reproduction	*	*	*	*	*

[a] Endpoints for surface water are given as percent surface water by volume; endpoints for sediment do not have volume units.
[b] Screening test- organisms exposed to laboratory control water and 100% surface water only.
[c] * = Not evaluated.
[d] Percent inhibition of growth (cell counts).
[e] Test endpoint- reduction in growth (cell density).
[f] Test endpoint- reduction in neonate production.
[g] Test endpoint- reduction in growth (dry weight).
[h] Test endpoint- reduction in survival.
[i] 96-h EC50 for malformations.

TABLE 2. (CONTINUED)

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994

[j] Test endpoint- increased number of malformations.
[k] Volume 1 of the ANL report (pp. 7 and 10) states that acute definitive tests were conducted with the frog; however, the authors of the current report could not find the data in Volumes 1 or 2 of the ANL report (Hayse, 1994).

TABLE 3. COMPARISON OF THE TOXICITY RESULTS FOUND IN THE CURRENT STUDY WITH THE RESULTS OF PREVIOUS STUDIES AT SW-11

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994
Green alga:						
	96-h Screen[b]	*[c]	*	86.5[d]	*	*
	96-h EC50[e]	51	*	*	*	*
	NOEC[e]	18	*	*	*	*
	LOEC[e]	32	*	*	*	*
Cladocera:						
Ceriodaphnia	48-h LC50	Not toxic	*	*	*	*
	7-d LC50	Not toxic	Not toxic	*	*	*
	NOEC[f]	Not toxic	Not toxic	*	*	*
	LOEC[f]	Not toxic	Not toxic	*	*	*
Daphnia	48-h Screen	*	*	Not toxic	*	*
	48-h LC50	*	*	*	*	*
Fathead minnow:						
	48-h Screen	*	*	Not toxic	*	*
	96-h LC50	47	*	*	*	*
	7-d LC50	40	*	*	Not toxic	*
	NOEC[g]	18	*	*	Not toxic	*
	LOEC[g]	32	*	*	Not toxic	*

TABLE 3. (CONTINUED)

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994
Frogs:						
Xenopus (FETAX)	96-h LC50	Not toxic	*	*	*	*
	96-h EC50[h]	No EC50	*	*	*	*
	NOEC[i]	32	*	*	*	*
	LOEC[i]	56	*	*	*	*
Rana	48-h Screen	*	*	Not toxic	*	*
	48-h LC50	*	*	*	*[j]	*
Amphipod:						
10-d acute	Survival	*	*	*	Not toxic	*
	Growth	*	*	*	Not toxic	*
28-d chronic	Survival	Not toxic	Not toxic	*	*	*
	Growth	Not toxic	Toxic	*	*	*
	Reproduction	Not toxic	*	*	*	*

[a] Endpoints for surface water are given as percent surface water by volume; endpoints for sediment do not have volume units.
[b] Screening test- organisms exposed to laboratory control water and 100% surface water only.
[c] * = Not evaluated.
[d] Percent inhibition of growth (cell counts).
[e] Test endpoint- reduction in growth (cell density).
[f] Test endpoint- reduction in neonate production.
[g] Test endpoint- reduction in survival.
[h] 96-h EC50 for malformations.
[i] Test endpoint- increased number of malformations.

TABLE 3. (CONTINUED)

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994

[j] Volume 1 of the ANL report (pp. 7 and 10) states that acute definitive tests were conducted with the frog; however, the authors of the current report could not find the data in Volumes 1 or 2 of the ANL report (Hayse, 1994).

TABLE 4. COMPARISON OF THE TOXICITY RESULTS FOUND IN THE CURRENT STUDY WITH THE RESULTS OF PREVIOUS STUDIES AT SW-12

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994
Green alga:						
	96-h Screen[b]	*[c]	*	93.5[d]	*	*
	96-h EC50[e]	79	*	*	*	*
	NOEC[e]	10	*	*	*	*
	LOEC[e]	18	*	*	*	*
Cladocera:						
Ceriodaphnia	48-h LC50	Not toxic	*	*	*	*
	7-d LC50	Not toxic	Not toxic	*	*	*
	NOEC[f]	18	Not toxic	*	*	*
	LOEC[f]	32	Not toxic	*	*	*
Daphnia	48-h Screen	*	*	Not toxic	*	*
	48-h LC50	*	*	*	*	*
Fathead minnow:						
	48-h Screen	*	*	Not toxic	*	*
	96-h LC50	No LC50	*	*	*	*
	7-d LC50	91	*	*	Not toxic	*
	NOEC[g]	18	*	*	Not toxic	*
	LOEC[g]	32	*	*	Not toxic	*

TABLE 4. (CONTINUED)

Bioassay	Endpoint	Value[a] UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994
Frogs:						
Xenopus (FETAX)	96-h LC50	Not toxic	*	*	*	*
	96-h EC50[h]	No EC50	*	*	*	*
	NOEC[i]	32	*	*	*	*
	LOEC[i]	56	*	*	*	*
Rana	48-h Screen	*		Not toxic	*	*
	48-h LC50	*	*	*	*[j]	*
Amphipod:						
10-d acute	Survival	*	*	*	81[k]	*
	Growth	*	*	*	[l]	*
28-d chronic	Survival	*	Not toxic	*	*	*
	Growth	*	Not toxic	*	*	*
	Reproduction	*	*	*	*	*

[a] Endpoints for surface water are given as percent surface water by volume; endpoints for sediment do not have volume units.
[b] Screening test- organisms exposed to laboratory control water and 100% surface water only.
[c] * = Not evaluated.
[d] Percent inhibition of growth (cell counts).
[e] Test endpoint- reduction in growth (cell density).
[f] Test endpoint- reduction in neonate production.
[g] Test endpoint- reduction in survival.
[h] 96-h EC50 for malformations.
[i] Test endpoint- increased number of malformations.

TABLE 4. (CONTINUED)

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994

[j] Volume 1 of the ANL report (pp. 7 and 10) states that acute definitive tests were conducted with the frog; however, the authors of the current report could not find the data in Volumes 1 or 2 of the ANL report (Hayse, 1994).

[k] Percent survival.

[l] Sample excluded from statistical analysis of growth by ANL since significant mortality occurred (Hayse, 1994).

TABLE 5. COMPARISON OF THE TOXICITY RESULTS FOUND IN THE CURRENT STUDY WITH THE RESULTS OF PREVIOUS STUDIES AT WELL JF8-3

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994
Green alga:						
	96-h Screen[b]	*[c]	*	*	*	85.8[d]
	96-h EC50[e]	39	*	*	*	*
	NOEC[e]	10	*	*	*	*
	LOEC[e]	18	*	*	*	*
Cladocera:						
Ceriodaphnia	48-h LC50	40	*	*	*	*
	7-d LC50	36	*	*	*	*
	NOEC[f]	10	*	*	*	*
	LOEC[f]	18	*	*	*	*
Daphnia	48-h Screen	*	*	*	*	0[g]
	48-h LC50	*	*	*	*	*
Fathead minnow:						
	48-h Screen	*	*	*	*	0[g]
	96-h LC50	13	*	*	*	*
	7-d LC50	13	*	*	*	*
	NOEC[h]	10	*	*	*	*
	LOEC[h]	18	*	*	*	*

TABLE 5. (CONTINUED)

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994
Frogs:						
Xenopus (FETAX)	96-h LC50	No LC50	*	*	*	*
	96-h EC50[i]	52	*	*	*	*
	NOEC[j]	18	*	*	*	*
	LOEC[j]	32	*	*	*	*
Rana	48-h Screen	*	*	*	*	0[g]
	48-h LC50	*	*	*	*	*
Amphipod:						
10-d acute	Survival	*	*	*	*	*
	Growth	*	*	*	*	*
28-d chronic	Survival	*	*	*	*	*
	Growth	*	*	*	*	*
	Reproduction	*	*	*	*	*

[a] Endpoints for groundwater are given as percent groundwater by volume; endpoints for sediment do not have volume units.
[b] Screening test- organisms exposed to laboratory control water and 100% surface water only.
[c] * = Not evaluated.
[d] Percent inhibition of growth (cell counts).
[e] Test endpoint- reduction in growth (cell density).
[f] Test endpoint- reduction in neonate production.
[g] Percent survival.
[h] Test endpoint- reduction in survival.

TABLE 5. (CONTINUED)

Bioassay	Endpoint	Value[a]				
		UMD May 1997	ESI June 1995	ANL April 1994	ANL May 1994	ANL June 1994

[i] 96-h EC50 for malformations.
[j] Test endpoint- increased number of malformations.

APPENDIX 1

GREEN ALGAL 96-H GROWTH TEST CONDUCTED ON J-FIELD
SW-10 SURFACE WATER (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static non-renewal
Date:	May 3-7, 1997
Investigator:	S. D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-10
Chemical Characteristics:	See Appendix 18
Test Medium:	Stock culture medium
Test Organism:	
Scientific Name:	Selenastrum capricornutum
Age at Start of Test:	Log growth
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	250 mL glass culture flasks with cheesecloth/cotton stoppers
Test Solution Volume:	100 mL
Initial Cell Density:	≈1 x 10^4 cells/mL
No. Replicates per Treatment:	3
Lighting:	Fluorescent; cool white; continuous; ≈300 foot candles
Shaking Rate:	100 cpm continuously
Endpoint:	Reduction in growth relative to control
Test Temperature:	25 ± 0.2 °C

Results:

Significant ($\alpha = 0.05$) reductions in growth (cell density) occurred at all concentrations down to 32% surface water by volume (Tables A1-1, A1-2, and A1-3). Growth was not affected by exposure to 10% or 18% surface water by volume. The NOEC and LOEC for reduction in growth are as follows:

NOEC = 18% surface water by volume.
LOEC = 32% surface water by volume.

The 96-h EC50 (reduction in growth), which was determined by the Trimmed Spearman-Karber method, is as follows:

96-h EC50 = 79.7% surface water by volume (95% confidence limits = 73.40-86.55).

TABLE A1-1. GREEN ALGAL J-FIELD SW-10 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - MEAN CELL DENSITY (CELLS/ML) AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Mean Cell Density	
		0H	96H
Growth Medium	1	11000	1257000
	2	11000	1203000
	3	11000	1317000
10	1	11000	1321000
	2	11000	1250000
	3	11000	1317000
18	1	11000	1205000
	2	11000	1167000
	3	11000	1213000
32	1	11000	1193000
	2	11000	1124000
	3	11000	1121000
56	1	11000	1063000
	2	11000	873000
	3	11000	1010000
100	1	11000	512000
	2	11000	560000
	3	11000	515000

Table A1-2. GREEN ALGAL J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - MEAN CELL DENSITY (CELLS/ML)

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.98
Alpha value:	0.01
Critical value:	0.86
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	4.72
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	84.33
Alpha value:	0.05
Critical value:	3.11
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A1-3
Alpha value:	0.05
Critical Value:	2.50
Conclusion:	Reject the null hypothesis that all groups are equal

Table A1-3. GREEN ALGAL J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON MEAN CELL DENSITY (CELLS/ML)

Conc (% by Vol)	No. of Reps	Mean Cell Density	T Statistic	Significance
Growth Medium	3	1259000		
10	3	1296000	-0.840	
18	3	1195000	1.454	
32	3	1146000	2.567	*
56	3	982000	6.292	*
100	3	529000	16.582	*

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.50).

APPENDIX 2

CLADOCERAN ACUTE AND 7-DAY SURVIVAL AND REPRODUCTION TEST CONDUCTED ON J-FIELD SW-10 SURFACE WATER (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static renewal (every 24 h)
Date:	May 2-9, 1997
Investigator:	S.D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-10
Chemical Characteristics:	See Appendix 18
Dilution Water:	
Source:	20% Perrier:80% RO water
Chemical Characteristics:	See Table A2-1
Test Organism:	
Scientific Name:	Ceriodaphnia dubia
Age at Start of Test:	<4 h
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	50 mL glass beaker
Test Solution Volume:	25 mL
No. Organisms/Replicate:	1
No. Organisms/Treatment:	10
Loading:	1 organism/beaker
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to each renewal
Endpoints:	Mortality of adults; number of neonates produced in 3 broods

Test Temperature:	25 ± 0.0 °C
Water Quality:	Table A2-1

Results:

Mortality:

48-h Exposure:

The data for the 48-h LC50 were obtained from the 7-d study. All organisms survived during the 48-h exposure to all of the SW-10 surface water treatments (Table A2-2). A 48-h LC50 could not be determined.

7-d Exposure:

All organisms survived during the 7-d exposure to all of the SW-10 surface water treatments (Table A2-3). A 7-d LC50 could not be determined.

Neonate Production:

J-Field SW-10 surface water did not affect ($\alpha = 0.05$) neonate production after 7 d of exposure (Tables A2-3 and A2-4). A NOEC and LOEC for the cladocerans, based on reduced neonate production, could not be determined.

TABLE A2-1. SUMMARY OF THE J-FIELD SW-10 SURFACE WATER BIOASSAY WATER QUALITY DATA FOR THE CLADOCERAN 7-DAY TEST (HIGH AQUIFER FLOW) - DISSOLVED OXYGEN (MG/L)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	8.3	8.0	7.4	7.8	7.9	8.3
Day 1						
0 H	8.3	8.0	7.7	8.0	8.0	8.3
24 H	8.2	7.7	7.2	7.9	7.9	8.2
Day 2						
0 H	8.3	8.2	8.1	8.0	8.1	8.2
24 H	8.2	8.1	7.9	7.8	7.7	8.1
Day 3						
0 H	8.3	8.1	8.0	7.9	8.0	8.1
24 H	8.2	8.0	7.8	7.9	7.9	8.0
Day 4						
0 H	8.3	8.1	7.8	7.8	8.1	8.2
24 H	8.3	8.1	8.1	7.9	8.0	8.1
Day 5						
0 H	8.3	8.1	7.9	7.7	7.9	8.1
24 H	8.1	8.2	8.0	7.8	8.0	8.1
Day 6						
0 H	8.3	8.0	7.7	7.9	8.0	8.1
24 H	8.1	8.1	7.9	8.0	7.9	8.0
Day 7						
24 H	8.0	7.9	7.8	7.7	7.7	7.9

TABLE A2-1. (CONTINUED) - pH (STANDARD UNITS)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.33	7.27	7.35	7.29	7.26	6.98
Day 1						
0 H	7.40	7.37	7.35	7.27	7.20	6.90
24 H	7.51	7.40	7.43	7.61	7.57	7.70
Day 2						
0 H	7.37	7.34	7.33	7.23	7.16	6.95
24 H	7.60	7.58	7.57	7.55	7.49	7.61
Day 3						
0 H	7.31	7.25	7.35	7.25	7.20	7.00
24 H	7.69	7.61	7.67	7.65	7.51	7.69
Day 4						
0 H	7.39	7.36	7.43	7.34	7.23	6.95
24 H	7.65	7.65	7.72	7.59	7.55	7.67
Day 5						
0 H	7.36	7.30	7.28	7.24	7.19	6.91
24 H	7.60	7.60	7.65	7.76	7.61	7.56
Day 6						
0 H	7.32	7.24	7.39	7.26	7.21	6.99
24 H	7.70	7.72	7.76	7.85	7.76	7.65
Day 7						
24 H	7.58	7.65	7.71	7.73	7.65	7.70

TABLE A2-1. (CONTINUED) - CONDUCTIVITY (μMHOS/CM)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	180	600
Day 1		
0 H	190	610
Day 2		
0 H	190	600
Day 3		
0 H	180	610
Day 4		
0 H	190	620
Day 5		
0 H	180	600
Day 6		
0 H	180	610
Day 7		
24 H	190	610

TABLE A2-1. (CONTINUED) - ALKALINITY (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	55	120
Day 1		
0 H	50	120
Day 2		
0 H	55	115
Day 3		
0 H	55	115
Day 4		
0 H	50	120
Day 5		
0 H	50	125
Day 6		
0H	55	120
Day 7		
24 H	50	115

TABLE A2-1. (CONTINUED) - HARDNESS (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	52	140
Day 1		
0 H	54	140
Day 2		
0 H	50	144
Day 3		
0 H	54	148
Day 4		
0 H	50	140
Day 5		
0 H	50	148
Day 6		
0 H	54	144
Day 7		
24 H	58	140

TABLE A2-2. CLADOCERAN J-FIELD SW-10 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL AFTER 48 HOURS OF EXPOSURE

Conc (% by Vol)	Number Tested	No. Alive at 48 Hours	Percent Alive
UMD/WREC Control	10	10	100
10	10	10	100
18	10	10	100
32	10	10	100
56	10	10	100
100	10	10	100

TABLE A2-3. CLADOCERAN J-FIELD SW-10 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL OF ADULTS, TOTAL NUMBER OF YOUNG, AND NUMBER OF YOUNG PRODUCED PER BROOD AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	Rep	Brood No. 1	Brood No. 2	Brood No. 3	Total Young
UMD/WREC Control	1	3	9	12	24
	2	4	7	14	25
	3	4	7	15	26
	4	4	7	14	25
	5	5	10	13	28
	6	3	7	16	26
	7	4	10	10	24
	8	3	7	12	22
	9	4	6	14	24
	10	4	8	12	24
10	1	3	6	13	22
	2	3	9	12	24
	3	6	10	13	29
	4	4	7	13	24
	5	4	7	15	26
	6	3	7	12	22
	7	3	7	14	24
	8	3	11	10	24
	9	3	7	11	21
	10	4	8	15	27
18	1	4	10	13	27
	2	3	7	13	23
	3	5	8	15	28
	4	4	9	15	28
	5	5	10	14	29
	6	4	8	12	24
	7	4	7	11	22
	8	3	8	14	25
	9	4	8	13	25
	10	3	8	12	23

TABLE A2-3. (CONTINUED)

Conc (% by Vol)	Rep	Brood No. 1	Brood No. 2	Brood No. 3	Total Young
32	1	1	10	14	25
	2	3	9	14	26
	3	3	7	13	23
	4	4	10	11	25
	5	4	9	16	29
	6	6	9	12	27
	7	4	11	11	26
	8	3	6	14	23
	9	4	7	12	23
	10	5	9	15	29
56	1	3	11	15	29
	2	6	14	10	30
	3	3	10	14	27
	4	4	8	15	27
	5	5	9	12	26
	6	3	7	17	27
	7	5	9	11	25
	8	5	6	10	21
	9	3	8	14	25
	10	5	9	13	27
100	1	4	7	14	25
	2	3	7	14	24
	3	3	6	8	17
	4	3	9	14	26
	5	4	7	14	25
	6	6	7	11	24
	7	0	4	12	16
	8	4	7	15	26
	9	3	8	13	24
	10	4	7	14	25

TABLE A2-4. CLADOCERAN J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS - NEONATE PRODUCTION AFTER 7 DAYS OF EXPOSURE

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

This test could not be performed because total number of replicates was greater than 50.

Chi-square Test for Normality:

Calculated test statistic:	2.19
Alpha value:	0.01
Critical value:	13.28
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	5.66
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	1.92
Alpha value:	0.05
Critical value:	2.45
Conclusion:	Fail to reject the null hypothesis that all groups are equal

APPENDIX 3

FATHEAD MINNOW ACUTE AND 7-DAY SURVIVAL AND GROWTH TEST CONDUCTED ON J-FIELD SW-10 SURFACE WATER (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static renewal (every 24 h)
Date:	May 2-9, 1997
Investigator:	S.D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-10
Chemical Characteristics:	See Appendix 18
Dilution Water:	
Source:	20% Perrier:80% RO water
Chemical Characteristics:	See Table A3-1
Test Organism:	
Scientific Name:	Pimephales promelas
Dry Weight:	0.35 mg (mean weight of controls at end of test)
Age at Start of Test:	<24 h
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	600 mL glass beaker
Test Solution Volume:	400 mL
No. Organisms/Replicate:	10
No. Organisms/Treatment:	40
Loading:	<0.5 g/L
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to each renewal

Test Temperature:	25 ± 0.0°C
Endpoints:	Mortality; growth
Water Quality:	Table A3-1

Results:

Mortality:

96-h Exposure:

The data for the 96-h LC50 were obtained from the 7-d study. Forty percent of the organisms exposed to 100% surface water died during the 96-h exposure; 12.5% or less died at the lower treatments (Table A3-2). A 96-h LC50 could not be determined.

7-d Exposure:

Significant ($\alpha = 0.05$) mortality occurred in fathead minnow larvae exposed to 100% and 56% surface water by volume for 7 d (Tables A3-3, A3-4, and A3-5). A 7-d LC50 could not be determined, because less than 50% mortality occurred in any of the surface water treatments.

The NOEC and LOEC for the larval fish, based on mortality, are as follows:

NOEC = 32% surface water by volume.
LOEC = 56% surface water by volume.

Growth:

The growth of fathead minnow larvae was significantly ($\alpha = 0.05$) reduced by a 7-d exposure to 32% surface water by volume (Tables A3-3, A3-6 and A3-7). Fathead minnow larval growth was not affected by exposure to 18% or 10% surface water by volume.

The NOEC and LOEC for the larval fish, based on growth, are as follows:

NOEC = 18% surface water by volume.
LOEC = 32% surface water by volume.

TABLE A3-1. SUMMARY OF THE J-FIELD SW-10 SURFACE WATER BIOASSAY WATER QUALITY DATA FOR THE FATHEAD MINNOW 7-DAY TEST (HIGH AQUIFER FLOW) - DISSOLVED OXYGEN (MG/L)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	8.3	8.0	7.4	7.8	7.9	8.3
Day 1						
0 H	8.3	8.0	7.7	8.0	8.0	8.3
24 H	8.2	7.7	7.3	7.7	7.6	8.2
Day 2						
0 H	8.3	8.2	8.1	8.0	8.1	8.2
24 H	8.1	7.6	7.5	7.8	7.9	8.0
Day 3						
0 H	8.3	8.1	8.0	7.9	8.0	8.1
24 H	8.1	7.6	7.5	7.7	7.7	8.0
Day 4						
0 H	8.3	8.1	7.8	7.8	8.1	8.2
24 H	8.0	7.7	7.6	7.6	7.8	7.9
Day 5						
0 H	8.3	8.1	7.9	7.7	7.9	8.1
24 H	8.0	7.5	7.6	7.5	7.6	7.7
Day 6						
0 H	8.3	8.0	7.7	7.9	8.0	8.1
24 H	8.0	7.6	7.3	7.3	7.5	7.3
Day 7						
24 H	8.1	7.7	7.5	7.2	7.4	7.6

TABLE A3-1. (CONTINUED) - pH (STANDARD UNITS)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.33	7.27	7.35	7.29	7.26	6.98
Day 1						
0 H	7.40	7.37	7.35	7.27	7.20	6.90
24 H	7.43	7.30	7.39	7.41	7.34	7.30
Day 2						
0 H	7.37	7.34	7.33	7.23	7.16	6.95
24 H	7.51	7.40	7.42	7.55	7.50	7.55
Day 3						
0 H	7.31	7.25	7.35	7.25	7.20	7.00
24 H	7.70	7.47	7.48	7.49	7.41	7.41
Day 4						
0 H	7.39	7.36	7.43	7.34	7.23	6.95
24 H	7.65	7.41	7.55	7.56	7.51	7.37
Day 5						
0 H	7.36	7.30	7.28	7.24	7.19	6.91
24 H	7.70	7.55	7.69	7.69	7.70	7.47
Day 6						
0 H	7.32	7.24	7.39	7.26	7.21	6.99
24 H	7.55	7.43	7.60	7.79	7.81	7.51
Day 7						
24 H	7.61	7.49	7.56	7.71	7.68	7.42

TABLE A3-1. (CONTINUED) - CONDUCTIVITY (μMHOS/CM)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	180	600
Day 1		
0 H	190	610
Day 2		
0 H	190	600
Day 3		
0 H	180	610
Day 4		
0 H	190	620
Day 5		
0 H	180	600
Day 6		
0 H	180	610
Day 7		
24 H	190	620

TABLE A3-1. (CONTINUED) - ALKALINITY (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	55	120
Day 1		
0 H	50	120
Day 2		
0 H	55	115
Day 3		
0 H	55	115
Day 4		
0 H	50	120
Day 5		
0 H	50	125
Day 6		
0 H	55	120
Day 7		
24 H	60	125

TABLE A3-1. (CONTINUED) - HARDNESS (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	52	140
Day 1		
0 H	54	140
Day 2		
0 H	50	144
Day 3		
0 H	54	148
Day 4		
0 H	50	140
Day 5		
0 H	50	148
Day 6		
0 H	54	144
Day 7		
24 H	54	148

TABLE A3-2. FATHEAD MINNOW J-FIELD SW-10 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Number Tested	No. Alive at 96 Hours	Percent Alive
UMD/WREC Control	A	10	10	100
	B	10	9	90
	C	10	10	100
	D	10	10	100
10	A	10	10	100
	B	10	10	100
	C	10	10	100
	D	10	10	100
18	A	10	9	90
	B	10	9	90
	C	10	9	90
	D	10	9	90
32	A	10	9	90
	B	10	7	70
	C	10	9	90
	D	10	10	100
56	A	10	10	100
	B	10	9	90
	C	10	10	100
	D	10	7	70
100	A	10	5	50
	B	10	5	50
	C	10	7	70
	D	10	7	70

TABLE A3-3. FATHEAD MINNOW J-FIELD SW-10 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW)- LARVAL SURVIVAL AND GROWTH AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	Rep	Number Larvae Alive	Percent Survival	Dry Weight[a] (mg)	Mean Dry Weight (mg)
UMD/WREC Control	1	10	100	0.345	
	2	9	90	0.321	
	3	10	100	0.379	
	4	10	100	0.359	0.351
10	1	10	100	0.389	
	2	10	100	0.335	
	3	9	90	0.329	
	4	10	100	0.356	0.352
18	1	9	90	0.342	
	2	9	90	0.328	
	3	8	80	0.318	
	4	9	90	0.330	0.330
32	1	9	90	0.287	
	2	7	70	0.294	
	3	9	90	0.308	
	4	10	100	0.295	0.296
56	1	10	100	0.290	
	2	8	80	0.290	
	3	7	70	0.218	
	4	7	70	0.275	0.268
100	1	5	50	0.179	
	2	4	40	0.127	
	3	7	70	0.229	
	4	7	70	0.261	0.199

[a] Dry weight = Total dry weight of larvae/number of original larvae (10).

TABLE A3-4. FATHEAD MINNOW J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - SURVIVAL OF LARVAE AFTER 7 DAYS OF EXPOSURE

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.94
Alpha value:	0.01
Critical value:	0.88
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	5.03
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	7.67
Alpha value:	0.05
Critical value:	2.77
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A3-5
Alpha value:	0.05
Critical value:	2.41
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A3-5. FATHEAD MINNOW J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON LARVAL SURVIVAL AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Survival (%)[a]	T Statistic	Significance
UMD/WREC Control	4	97.5		
10	4	97.5	0.000	
18	4	87.5	1.635	
32	4	87.5	1.513	
56	4	80.0	2.549	*
100	4	57.5	5.268	*

[a] Values given are actual percent survival means rather than arc sine square root transformed means which were used in the statistical analysis.

* Significantly different at alpha = 0.05 (Dunnett's Critical value = 2.41).

TABLE A3-6. FATHEAD MINNOW J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - DRY WEIGHT OF LARVAE AFTER 7 DAYS OF EXPOSURE[a]

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.97
Alpha value:	0.01
Critical value:	0.84
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	4.78
Alpha value:	0.01
Critical value:	11.34
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	7.36
Alpha value:	0.05
Critical value:	3.49
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A3-7
Alpha value:	0.05
Critical value:	2.29
Conclusion:	Reject the null hypothesis that all groups are equal

[a] The 100 and 56% surface water treatments were not included in the statistical analysis because significant mortality occurred after 7 days of exposure.

TABLE A3-7. FATHEAD MINNOW J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON LARVAL GROWTH AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Dry Weight (mg)	T Statistic	Significance
UMD/WREC Control	4	0.351		
10	4	0.352	-0.091	
18	4	0.330	1.569	
32	4	0.296	4.013	*

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.29)

APPENDIX 4

FROG EMBRYO TERATOGENESIS ASSAY - Xenopus (FETAX)
CONDUCTED ON J-FIELD SW-10 SURFACE WATER
(HIGH AQUIFER FLOW)

Test Method:	ASTM Designation E 1439-91 ASTM (1991)
Type of Test:	Static renewal (every 24 h)
Date:	May 5-9, 1997
Investigator:	S. D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-10
Chemical Characteristics:	See Appendix 18
Test Medium:	
Source:	FETAX solution
pH characteristics:	See Table A4-1
Test Organism:	
Scientific Name:	Xenopus laevis
Age at Start of Test:	Stage 8 blastula to stage 11 gastrulae
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	Glass petri dishes
Test Solution Volume:	10 mL
No. Organisms/Replicate:	25
No. Organisms/Treatment:	Control: 50 Surface water: 50
Loading:	n/a
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to renewals

Endpoints:	Mortality; malformation
Test Temperature:	24 ± 0.2°C

Results:

Mortality:

Embryo survival was not affected by exposure for 4 days to SW-10 surface water (Tables A4-2 and A4-3).

Malformations:

Significant (α = 0.05) embryo malformations occurred in the SW-10 100% surface water treatment (Tables A4-2, A4-4, and A4-5). An EC50 for malformations could not be determined because less than 50% mortality occurred in any of the test treatments. The NOEC and LOEC for the embryos, based on increased numbers of malformations, are as follows:

NOEC = 56% surface water by volume.
LOEC = 100% surface water by volume.

The types of malformed embryos are given in Table A4-6.

TABLE A4-1. SUMMARY OF THE J-FIELD SW-10 SURFACE WATER BIOASSAY pH (STANDARD UNITS) DATA FOR FETAX (HIGH AQUIFER FLOW)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.45	7.36	7.40	7.30	7.24	7.00
Day 1						
0 H	7.50	7.43	7.51	7.43	7.31	6.95
Day 2						
0 H	7.45	7.38	7.33	7.30	7.24	6.91
Day 3						
0 H	7.51	7.42	7.57	7.38	7.33	6.99

TABLE A4-2. FETAX J-FIELD SW-10 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - PERCENT EMBRYO SURVIVAL AND MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Number Embryos Alive	Percent Survival	Number Embryos Malformed	Percent Malformed
UMD/WREC Control	1	25	100	2	8.0
	2	24	96	1	4.2
10	1	25	100	2	8.0
	2	24	96	2	8.3
18	1	24	96	3	12.5
	2	25	100	2	8.0
32	1	24	96	3	12.5
	2	23	92	3	13.0
56	1	23	92	4	17.4
	2	21	84	2	9.5
100	1	19	76	4	21.1
	2	23	92	4	17.4

TABLE A4-3. FETAX J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - PERCENT EMBRYO SURVIVAL AFTER 96 HOURS OF EXPOSURE

Data Transformation:

Arc-sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.90
Alpha value:	0.01
Critical value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed.

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	1.08
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	2.82
Alpha value:	0.05
Critical value:	4.39
Conclusion:	Fail to reject the null hypothesis that all groups are equal

TABLE A4-4. FETAX J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - PERCENT EMBRYO MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.97
Alpha value:	0.01
Critical Value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	6.22
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	4.48
Alpha value:	0.05
Critical value:	4.39
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A4-5
Alpha value:	0.05
Critical value:	2.83
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A4-5. FETAX J-FIELD SW-10 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON EMBRYO MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Normal Embryos (%)[a]	T Statistic	Significance
UMD/WREC Control	2	93.9		
10	2	91.9	0.889	
18	2	89.8	1.604	
32	2	87.3	2.454	
56	2	86.5	2.593	
100	2	80.7	4.290	*

[a] Values given are actual percent normal embryo means rather than arc sine square root transformed means which were used in the statistical analysis.

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.83).

TABLE A4-6. FETAX J-FIELD SW-10 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - TYPE AND NUMBER OF MALFORMED EMBRYOS AFTER 96 HOURS OF EXPOSURE

Malformation	Test Concentrations (% Surface Water by Volume)											
	0		10		18		32		56		100	
	Rep		Rep		Rep		Rep		Rep		Rep	
	1	2	1	2	1	2	1	2	1	2	1	2
Severe												
Gut, coiling	1		1	1	1						2	1
Edema:												
Multiple			1		2	2	1	3	3		1	1
Cardiac												
Abdominal										1	1	2
Facial												
Cephalic												
Blisters												
Tail												
Notochord	1	1	1				2			1		
Fin												
Face									1			
Eye												
Brain												
Hemorrhage												
Cardiac												
Other												

APPENDIX 5

GREEN ALGAL 96-H GROWTH TEST CONDUCTED ON J-FIELD
SW-11 SURFACE WATER (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static non-renewal
Date:	May 3-7, 1997
Investigator:	S. D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-11
Chemical Characteristics:	See Appendix 19
Test Medium:	Stock culture medium
Test Organism:	
Scientific Name:	Selenastrum capricornutum
Age at Start of Test:	Log growth
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	250 mL glass culture flasks with cheesecloth/cotton stoppers
Test Solution Volume:	100 mL
Initial Cell Density:	≈1 x 10^4 cells/mL
No. Replicates per Treatment:	3
Lighting:	Fluorescent; cool white; continuous; ≈300 foot candles
Shaking Rate:	100 cpm continuously
Endpoint:	Reduction in growth relative to control
Test Temperature:	25 ± 0.2 °C

Results:

Exposure to SW-11 raw surface water (100%) killed all algal cells after 96 hours of exposure. Significant ($\alpha = 0.05$) reductions in growth (cell density) occurred at 56% and 32% surface water by volume (Tables A5-1, A5-2, and A5-3). Growth was not affected by exposure to 10% or 18% surface water by volume. The NOEC and LOEC for reduction in growth are as follows:

NOEC = 18% surface water by volume.
LOEC = 32% surface water by volume.

The 96-h EC50 (reduction in growth), which was determined by the Trimmed Spearman-Karber method, is as follows:

96-h EC50 = 51.1% surface water by volume (95% confidence limits = 47.38-55.05).

TABLE A5-1. GREEN ALGAL J-FIELD SW-11 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - MEAN CELL DENSITY (CELLS/ML) AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Mean Cell Density	
		0H	96H
Growth Medium	1	11000	1257000
	2	11000	1203000
	3	11000	1317000
10	1	11000	1269000
	2	11000	1282000
	3	11000	1244000
18	1	11000	1154000
	2	11000	1195000
	3	11000	1200000
32	1	11000	1016000
	2	11000	1083000
	3	11000	1096000
56	1	11000	701000
	2	11000	624000
	3	11000	712000
100	1	11000	DEAD
	2	11000	DEAD
	3	11000	DEAD

Table A5-2. GREEN ALGAL J-FIELD SW-11 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - MEAN CELL DENSITY (CELLS/ML)

Data Transformation:	
None	
Shapiro-Wilk's Test for Normality:	
Calculated test statistic:	0.93
Alpha value:	0.01
Critical value:	0.84
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed
Bartlett's Test for Homogeneity of Variances:	
Calculated test statistic:	2.35
Alpha value:	0.01
Critical value:	13.28
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous
ANOVA:	
Calculated test statistic:	105.92
Alpha value:	0.05
Critical value:	3.48
Conclusion:	Reject the null hypothesis that all groups are equal
Dunnett's Test:	
Calculated test statistic:	See Table A5-3
Alpha value:	0.05
Critical Value:	2.47
Conclusion:	Reject the null hypothesis that all groups are equal

[a] The 100% surface water treatment was not included in the statistical analysis because all algal cells were dead after 96 hours of exposure.

Table A5-3. GREEN ALGAL J-FIELD SW-11 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON MEAN CELL DENSITY (CELLS/ML)

Conc (% by Vol)	No. of Reps	Mean Cell Density	T Statistic	Significance
Growth Medium	3	1259000		
10	3	1265000	-0.179	
18	3	1183000	2.270	
32	3	1065000	5.795	*
56	3	679000	17.327	*

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.47).

APPENDIX 6

CLADOCERAN ACUTE AND 7-DAY SURVIVAL AND REPRODUCTION TEST CONDUCTED ON J-FIELD SW-11 SURFACE WATER (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static renewal (every 24 h)
Date:	April 30- May 7, 1997
Investigator:	S.D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-11
Chemical Characteristics:	See Appendix 19
Dilution Water:	
Source:	20% Perrier:80% RO water
Chemical Characteristics:	See Table A6-1
Test Organism:	
Scientific Name:	Ceriodaphnia dubia
Age at Start of Test:	<4 h
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	50 mL glass beaker
Test Solution Volume:	25 mL
No. Organisms/Replicate:	1
No. Organisms/Treatment:	10
Loading:	1 organism/beaker
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to each renewal
Endpoints:	Mortality of adults; number of neonates produced in 3 broods

Test Temperature:	25 ± 0.2°C
Water Quality:	Table A6-1

Results:

Mortality:

48-h Exposure:

The data for the 48-h LC50 were obtained from the 7-d study. All organisms survived during the 48-h exposure to all of the SW-11 surface water treatments (Table A6-2). A 48-h LC50 could not be determined.

7-d Exposure:

All organisms survived during the 7-d exposure to all of the SW-11 surface water treatments (Table A6-3). A 7-d LC50 could not be determined.

Neonate Production:

J-Field SW-11 surface water did not affect ($\alpha = 0.05$) neonate production after 7 d of exposure (Tables A6-3 and A6-4). An NOEC and LOEC for the cladocerans, based on reduced neonate production, could not be determined.

TABLE A6-1. SUMMARY OF THE J-FIELD SW-11 SURFACE WATER BIOASSAY WATER QUALITY DATA FOR THE CLADOCERAN 7-DAY TEST (HIGH AQUIFER FLOW) - DISSOLVED OXYGEN (MG/L)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	8.3	8.1	8.1	7.8	7.8	6.8
Day 1						
0 H	8.3	8.1	8.1	8.0	7.4	6.9
24 H	8.2	8.0	8.0	7.7	7.8	6.1
Day 2						
0 H	8.3	8.2	8.3	8.2	8.0	7.0
24 H	8.2	8.1	8.1	8.1	8.0	7.8
Day 3						
0 H	8.3	8.2	8.2	8.1	8.1	7.2
24 H	8.3	8.2	8.1	8.0	8.0	7.7
Day 4						
0 H	8.3	8.2	8.2	8.1	8.0	7.0
24 H	8.3	8.1	8.0	8.0	8.1	7.5
Day 5						
0 H	8.3	8.1	8.1	8.0	8.0	7.1
24 H	8.2	8.0	7.5	8.1	8.0	7.0
Day 6						
0 H	8.3	8.1	8.0	8.0	7.9	7.3
24 H	8.3	8.0	7.7	7.9	8.0	7.3
Day 7						
24 H	8.2	7.9	7.8	8.0	7.9	7.6

TABLE A6-1. (CONTINUED) - pH (STANDARD UNITS)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.44	7.19	7.18	7.12	7.00	6.71
Day 1						
0 H	7.35	7.09	7.21	7.17	7.10	6.66
24 H	7.28	7.28	7.38	7.65	7.66	7.90
Day 2						
0 H	7.33	7.13	7.23	7.32	7.30	7.01
24 H	7.45	7.88	8.00	7.96	8.01	8.19
Day 3						
0 H	7.40	7.16	7.20	7.27	7.23	6.95
24 H	7.51	7.83	8.03	7.91	8.00	8.14
Day 4						
0 H	7.37	7.20	7.25	7.21	7.17	6.80
24 H	7.60	7.77	7.94	7.97	8.03	8.10
Day 5						
0 H	7.31	7.24	7.15	7.10	7.02	6.78
24 H	7.69	7.71	7.89	7.93	7.97	8.16
Day 6						
0 H	7.39	7.20	7.12	7.08	6.99	6.75
24 H	7.65	7.65	7.77	7.89	8.03	8.09
Day 7						
24 H	7.61	7.74	7.86	7.90	8.00	8.06

TABLE A6-1. (CONTINUED) - CONDUCTIVITY (μMHOS/CM)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	180	710
Day 1		
0 H	180	720
Day 2		
0 H	180	710
Day 3		
0 H	190	700
Day 4		
0 H	190	710
Day 5		
0 H	180	700
Day 6		
0 H	190	700
Day 7		
24 H	180	720

TABLE A6-1. (CONTINUED) - ALKALINITY (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	55	115
Day 1		
0 H	50	120
Day 2		
0 H	55	110
Day 3		
0 H	50	115
Day 4		
0 H	55	115
Day 5		
0 H	55	110
Day 6		
0 H	50	115
Day 7		
24 H	60	120

TABLE A6-1. (CONTINUED) - HARDNESS (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	50	112
Day 1		
0 H	50	110
Day 2		
0 H	52	110
Day 3		
0 H	54	114
Day 4		
0 H	50	110
Day 5		
0 H	54	110
Day 6		
0 H	50	112
Day 7		
24 H	58	114

TABLE A6-2. CLADOCERAN J-FIELD SW-11 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL AFTER 48 HOURS OF EXPOSURE

Conc (% by Vol)	Number Tested	No. Alive at 48 Hours	Percent Alive
UMD/WREC Control	10	10	100
10	10	10	100
18	10	10	100
32	10	10	100
56	10	10	100
100	10	10	100

TABLE A6-3. CLADOCERAN J-FIELD SW-11 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL OF ADULTS, TOTAL NUMBER OF YOUNG, AND NUMBER OF YOUNG PRODUCED PER BROOD AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	Rep	Brood No. 1	Brood No. 2	Brood No. 3	Total Young
UMD/WREC Control	1	4	8	15	27
	2	4	9	11	24
	3	4	8	12	24
	4	5	8	13	26
	5	4	7	14	25
	6	3	9	13	25
	7	3	10	13	26
	8	3	9	12	24
	9	3	7	12	22
	10	4	8	14	26
10	1	3	10	12	25
	2	4	8	15	27
	3	5	9	9	23
	4	3	7	14	24
	5	4	8	14	26
	6	2	6	13	21
	7	4	7	16	27
	8	4	9	11	24
	9	4	8	15	27
	10	2	7	14	23
18	1	4	8	14	26
	2	4	6	16	26
	3	3	4	11	18
	4	4	6	15	25
	5	3	8	16	27
	6	4	0	16	20
	7	3	8	14	25
	8	3	7	10	20
	9	3	7	12	22
	10	3	8	14	25

TABLE A6-3. (CONTINUED)

Conc (% by Vol)	Rep	Brood No. 1	Brood No. 2	Brood No. 3	Total Young
32	1	3	7	17	27
	2	3	10	15	28
	3	3	9	16	28
	4	2	9	11	22
	5	4	7	16	27
	6	2	8	13	23
	7	3	6	12	21
	8	3	11	12	26
	9	3	5	16	24
	10	3	7	15	25
56	1	4	11	14	29
	2	2	6	13	21
	3	0	8	13	21
	4	2	9	15	26
	5	3	8	14	25
	6	2	5	14	21
	7	4	8	10	22
	8	3	8	12	23
	9	2	6	17	25
	10	2	6	14	22
100	1	4	10	14	28
	2	3	5	19	27
	3	3	9	12	24
	4	3	6	12	21
	5	1	6	11	18
	6	3	7	14	24
	7	3	6	13	22
	8	2	5	15	22
	9	4	9	11	24
	10	2	8	7	17

TABLE A6-4. CLADOCERAN J-FIELD SW-11 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - NEONATE PRODUCTION AFTER 7 DAYS OF EXPOSURE

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

This test could not be performed because total number of replicates was greater than 50.

Chi-square Test for Normality:

Calculated test statistic:	7.21
Alpha value:	0.01
Critical value:	13.28
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	7.47
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	1.42
Alpha value:	0.05
Critical value:	2.45
Conclusion:	Fail to reject the null hypothesis that all groups are equal

APPENDIX 7

FATHEAD MINNOW ACUTE AND 7-DAY SURVIVAL AND GROWTH TEST CONDUCTED ON J-FIELD SW-11 SURFACE WATER (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static renewal (every 24 h)
Date:	April 30- May 7, 1997
Investigator:	S.D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-11
Chemical Characteristics:	See Appendix 19
Dilution Water:	
Source:	20% Perrier:80% RO water
Chemical Characteristics:	See Table A7-1
Test Organism:	
Scientific Name:	Pimephales promelas
Dry Weight:	0.47 mg (mean weight of controls at end of test)
Age at Start of Test:	<24 h
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	600 mL glass beaker
Test Solution Volume:	400 mL
No. Organisms/Replicate:	10
No. Organisms/Treatment:	40
Loading:	<0.5 g/L
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to each renewal

Endpoints:	Mortality; growth
Test Temperature:	25 ± 0.2°C
Water Quality:	Table A7-1

Results:

Mortality:

96-h Exposure:

The data for the 96-h LC50 were obtained from the 7-d study. Mortality in excess of 50% occurred at the two highest treatments during the 96-h exposure (Table A7-2). The 96-h LC50, determined by the Trimmed Spearman-Karber method, is as follows:

96-h LC50 = 46.5% surface water by volume (95% confidence limits = 41.52-52.01).

7-d Exposure:

Significant (α = 0.05) mortality occurred in fathead minnow larvae exposed to all concentrations down to 32% surface water by volume for 7 d (Tables A7-3, A7-4, and A7-5). The 7-d LC50, which was determined by the Trimmed Spearman-Karber method, is as follows:

7-d LC50 = 40.4% surface water by volume (95% confidence limits = 33.30-48.97).

The NOEC and LOEC for the larval fish, based on mortality, are as follows:

NOEC = 18% surface water by volume.
LOEC = 32% surface water by volume.

Growth:

The growth of fathead minnow larvae was not affected (α = 0.05) by a 7-d exposure to 10% or 18% surface water by volume (Tables A7-3, A7-6 and A7-7). Data from the 100%, 56% and 32% surface water by volume treatments were not included in the statistical analysis for growth because significant mortality occurred at these treatments.

TABLE A7-1. SUMMARY OF THE J-FIELD SW-11 SURFACE WATER BIOASSAY WATER QUALITY DATA FOR THE FATHEAD MINNOW 7-DAY TEST (HIGH AQUIFER FLOW) - DISSOLVED OXYGEN (MG/L)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	8.3	8.1	8.1	7.8	7.8	6.8
Day 1						
0 H	8.3	8.1	8.1	8.0	7.4	6.9
24 H	8.0	7.8	7.7	7.6	7.3	5.7
Day 2						
0 H	8.3	8.2	8.3	8.2	8.0	7.0
24 H	8.3	7.8	7.6	7.6	7.5	7.6
Day 3						
0 H	8.3	8.2	8.2	8.1	8.1	7.2
24 H	8.1	7.7	7.5	7.5	7.2	7.0
Day 4						
0 H	8.3	8.2	8.2	8.1	8.0	7.0
24 H	8.1	7.7	7.6	7.5	7.4	6.8
Day 5						
0 H	8.3	8.1	8.1	8.0	8.0	7.1
24 H	8.0	7.8	7.5	7.4	7.3	6.7
Day 6						
0 H	8.3	8.1	8.0	8.0	7.9	7.3
24 H	8.1	7.6	7.4	7.5	7.2	6.5
Day 7						
24 H	8.0	7.7	7.6	7.3	7.3	6.2

TABLE A7-1. (CONTINUED) - pH (STANDARD UNITS)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.44	7.19	7.18	7.12	7.00	6.71
Day 1						
0 H	7.35	7.09	7.21	7.17	7.10	6.66
24 H	7.57	7.74	7.71	7.76	7.71	7.69
Day 2						
0 H	7.33	7.13	7.23	7.32	7.30	7.01
24 H	7.74	7.74	7.75	7.78	7.87	7.95
Day 3						
0 H	7.40	7.16	7.20	7.27	7.23	6.95
24 H	7.69	7.70	7.72	7.80	7.91	7.92
Day 4						
0 H	7.37	7.20	7.25	7.21	7.17	6.80
24 H	7.60	7.67	7.74	7.75	7.80	7.87
Day 5						
0 H	7.31	7.24	7.15	7.10	7.02	6.78
24 H	7.70	7.72	7.69	7.63	7.69	7.75
Day 6						
0 H	7.39	7.20	7.12	7.08	6.99	6.75
24 H	7.65	7.65	7.75	7.70	7.81	7.87
Day 7						
24 H	7.69	7.69	7.64	7.76	7.79	7.90

TABLE A7-1. (CONTINUED) - CONDUCTIVITY (μMHOS/CM)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	180	710
Day 1		
0 H	180	720
Day 2		
0 H	180	710
Day 3		
0 H	190	700
Day 4		
0 H	190	710
Day 5		
0 H	180	700
Day 6		
0 H	190	700
Day 7		
24 H	200	720

TABLE A7-1. (CONTINUED) - ALKALINITY (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	55	115
Day 1		
0 H	50	120
Day 2		
0 H	55	110
Day 3		
0 H	50	115
Day 4		
0 H	55	115
Day 5		
0 H	55	110
Day 6		
0 H	50	115
Day 7		
24 H	55	120

TABLE A7-1. (CONTINUED) - HARDNESS (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	50	112
Day 1		
0 H	50	110
Day 2		
0 H	52	110
Day 3		
0 H	54	114
Day 4		
0 H	50	110
Day 5		
0 H	54	110
Day 6		
0 H	50	112
Day 7		
24 H	54	110

TABLE A7-2. FATHEAD MINNOW J-FIELD SW-11 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Number Tested	No. Alive at 96 Hours	Percent Alive
UMD/WREC Control	A	10	10	100
	B	10	10	100
	C	10	10	100
	D	10	10	100
10	A	10	9	90
	B	10	9	90
	C	10	9	90
	D	10	9	90
18	A	10	10	100
	B	10	9	90
	C	10	9	90
	D	10	8	80
32	A	10	9	90
	B	10	7	70
	C	10	9	90
	D	10	9	90
56	A	10	3	30
	B	10	2	20
	C	10	2	20
	D	10	2	20
100	A	10	3	30
	B	10	4	40
	C	10	4	40
	D	10	6	60

TABLE A7-3. FATHEAD MINNOW J-FIELD SW-11 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - LARVAL SURVIVAL AND GROWTH AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	Rep	Number Larvae Alive	Percent Survival	Dry Weight[a] (mg)	Mean Dry Weight (mg)
UMD/WREC Control	1	10	100	0.425	
	2	9	90	0.506	
	3	10	100	0.405	
	4	10	100	0.544	0.470
10	1	9	90	0.480	
	2	9	90	0.427	
	3	9	90	0.579	
	4	9	90	0.408	0.474
18	1	6	60	0.517	
	2	9	90	0.344	
	3	9	90	0.552	
	4	7	70	0.376	0.447
32	1	6	60	0.210	
	2	7	70	0.208	
	3	8	80	0.410	
	4	7	70	0.350	0.295
56	1	3	30	0.089	
	2	2	20	0.091	
	3	2	20	0.078	
	4	2	20	0.046	0.076
100	1	1	10	0.033	
	2	3	30	0.113	
	3	4	40	0.120	
	4	3	30	0.164	0.108

[a] Dry weight = Total dry weight of larvae/number of original larvae (10).

TABLE A7-4. FATHEAD MINNOW J-FIELD SW-11 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - SURVIVAL OF LARVAE AFTER 7 DAYS OF EXPOSURE

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.94
Alpha value:	0.01
Critical value:	0.88
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Test could not be performed because at least one group has zero variance.

Steel's Many-One Rank Test:

Calculated test statistic:	See Table A7-5
Alpha value:	0.05
Critical value:	10.00
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A7-5. FATHEAD MINNOW J-FIELD SW-11 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF STEEL'S MANY-ONE RANK TEST ON LARVAL SURVIVAL AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Survival (%)[a]	Rank Sum	Critical Value	Significance
UMD/WREC Control	4	97.5			
10	4	90.0	12.00	10.00	
18	4	77.5	11.00	10.00	
32	4	70.0	10.00	10.00	*
56	4	22.5	10.00	10.00	*
100	4	27.5	10.00	10.00	*

[a] Values given are actual percent survival means rather than arc sine square root transformed means which were used in the statistical analysis.

* Significantly different at alpha = 0.05.

TABLE A7-6. FATHEAD MINNOW J-FIELD SW-11 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - DRY WEIGHT OF LARVAE AFTER 7 DAYS OF EXPOSURE[a]

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.90
Alpha value:	0.01
Critical value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	0.54
Alpha value:	0.01
Critical value:	9.21
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	0.12
Alpha value:	0.05
Critical value:	4.26
Conclusion:	Fail to reject the null hypothesis that all groups are equal

[a] The 100%, 56% and 32% surface water by volume treatments were not included in the statistical analysis for growth because there was significant mortality at these treatments.

APPENDIX 8

FROG EMBRYO TERATOGENESIS ASSAY - Xenopus (FETAX)
CONDUCTED ON J-FIELD SW-11 SURFACE WATER
(HIGH AQUIFER FLOW)

Test Method:	ASTM Designation E 1439-91 ASTM (1991)
Type of Test:	Static renewal (every 24 h)
Date:	May 2-6, 1997
Investigator:	S. D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-11
Chemical Characteristics:	See Appendix 19
Test Medium:	
Source:	FETAX solution
pH characteristics:	See Table A8-1
Test Organism:	
Scientific Name:	Xenopus laevis
Age at Start of Test:	Stage 8 blastula to stage 11 gastrulae
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	Glass petri dishes
Test Solution Volume:	10 mL
No. Organisms/Replicate:	25
No. Organisms/Treatment:	Control: 50 Surface water: 50
Loading:	n/a
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to renewals

Endpoints:	Mortality; malformation
Test Temperature:	24 ± 0.2°C

Results:

Mortality:

Embryo survival was not affected by exposure for 4 days to SW-11 surface water (Tables A8-2 and A8-3).

Malformations:

Significant (α = 0.05) embryo malformations occurred in the SW-11 treatments of 100% and 56% surface water by volume (Tables A8-2, A8-4, and A8-5). An EC50 for malformations could not be determined because less than 50% malformations occurred in any of the treatments. The NOEC and LOEC for the embryos, based on increased numbers of malformations, are as follows:

NOEC = 32% surface water by volume.
LOEC = 56% surface water by volume.

The types of malformed embryos are given in Table A8-6.

TABLE A8-1. SUMMARY OF THE J-FIELD SW-11 SURFACE WATER BIOASSAY pH (STANDARD UNITS) DATA FOR FETAX (HIGH AQUIFER FLOW)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.47	7.25	7.33	7.40	7.36	7.01
Day 1						
0 H	7.51	7.26	7.30	7.35	7.31	6.95
Day 2						
0 H	7.49	7.33	7.37	7.32	7.26	6.80
Day 3						
0 H	7.45	7.35	7.23	7.17	7.10	6.78

TABLE A8-2. FETAX J-FIELD SW-11 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - PERCENT EMBRYO SURVIVAL AND MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Number Embryos Alive	Percent Survival	Number Embryos Malformed	Percent Malformed
UMD/WREC Control	1	23	92	2	8.7
	2	25	100	1	4.0
10	1	25	100	1	4.0
	2	23	92	1	4.3
18	1	24	96	3	12.5
	2	22	88	1	4.5
32	1	24	96	2	8.3
	2	23	92	3	13.0
56	1	24	96	4	16.7
	2	22	88	4	18.2
100	1	20	80	4	20.0
	2	19	76	5	26.3

TABLE A8-3. FETAX J-FIELD SW-11 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - PERCENT EMBRYO SURVIVAL AFTER 96 HOURS OF EXPOSURE

Data Transformation:

Arc-sine square-root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.87
Alpha value:	0.01
Critical value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	1.46
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	2.27
Alpha value:	0.05
Critical value:	4.39
Conclusion:	Fail to reject the null hypothesis that all groups are equal

TABLE A8-4. FETAX J-FIELD SW-11 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - PERCENT EMBRYO MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.97
Alpha value:	0.01
Critical Value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	4.89
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	7.36
Alpha value:	0.05
Critical value:	4.39
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A8-5
Alpha value:	0.05
Critical value:	2.83
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A8-5. FETAX J-FIELD SW-11 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON EMBRYO MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Normal Embryos (%)[a]	T Statistic	Significance
UMD/WREC Control	2	93.9		
10	2	95.9	-0.692	
18	2	91.5	0.707	
32	2	89.4	1.437	
56	2	82.5	3.140	*
100	2	76.9	4.332	*

[a] Values given are actual percent normal embryo means rather than arc sine square root transformed means which were used in the statistical analysis.

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.83).

TABLE A8-6. FETAX J-FIELD SW-11 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - TYPE AND NUMBER OF MALFORMED EMBRYOS AFTER 96 HOURS OF EXPOSURE

Malformation	Test Concentrations (% Surface Water by Volume)											
	0		10		18		32		56		100	
	Rep		Rep		Rep		Rep		Rep		Rep	
	1	2	1	2	1	2	1	2	1	2	1	2
Severe										1		
Gut, coiling	2			1	2	1	1	1	2	2	2	3
Edema:												
Multiple		1		1		1	1	1		1	2	2
Cardiac												
Abdominal									1			
Facial												
Cephalic												
Blisters												
Tail												
Notochord								1	1			
Fin												
Face												
Eye												
Brain												
Hemorrhage												
Cardiac												
Other												

APPENDIX 9

GREEN ALGAL 96-H GROWTH TEST CONDUCTED ON J-FIELD
SW-12 SURFACE WATER (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static non-renewal
Date:	May 3-7, 1997
Investigator:	S. D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-12
Chemical Characteristics:	See Appendix 21
Test Medium:	Stock culture medium
Test Organism:	
Scientific Name:	Selenastrum capricornutum
Age at Start of Test:	Log growth
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	250 mL glass culture flasks with cheesecloth/cotton stoppers
Test Solution Volume:	100 mL
Initial Cell Density:	$\approx 1 \times 10^4$ cells/mL
No. Replicates per Treatment:	3
Lighting:	Fluorescent; cool white; continuous; ≈300 foot candles
Shaking Rate:	100 cpm continuously
Endpoint:	Reduction in growth relative to control
Test Temperature:	25 ± 0.2 °C

Results:

Significant (α = 0.05) reductions in growth (cell density) occurred at all concentrations down to 18% surface water by volume (Tables A9-1, A9-2, and A9-3). Growth was not affected by exposure to 10% surface water by volume. The NOEC and LOEC for reduction in growth are as follows:

NOEC = 10% surface water by volume.
LOEC = 18% surface water by volume.

The 96-h EC50 (reduction in growth), which was determined by the Trimmed Spearman-Karber method, is as follows:

96-h EC50 = 79.0% surface water by volume (95% confidence limits = 68.01-91.67).

TABLE A9-1. GREEN ALGAL J-FIELD SW-12 SURFACE WATER TOXICITY DATA (HIGH AQUIFER FLOW) - MEAN CELL DENSITY (CELLS/ML) AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Mean Cell Density	
		0H	96H
Growth Medium	1	11000	1257000
	2	11000	1203000
	3	11000	1317000
10	1	11000	1217000
	2	11000	1254000
	3	11000	1120000
18	1	11000	1198000
	2	11000	1109000
	3	11000	1134000
32	1	11000	998000
	2	11000	1040000
	3	11000	1048000
56	1	11000	829000
	2	11000	862000
	3	11000	802000
100	1	11000	515000
	2	11000	467000
	3	11000	486000

Table A9-2. GREEN ALGAL J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - MEAN CELL DENSITY (CELLS/ML)

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.97
Alpha value:	0.01
Critical value:	0.86
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	3.03
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	121.57
Alpha value:	0.05
Critical value:	3.11
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A9-3
Alpha value:	0.05
Critical Value:	2.50
Conclusion:	Reject the null hypothesis that all groups are equal

Table A9-3. GREEN ALGAL J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON MEAN CELL DENSITY (CELLS/ML)

Conc (% by Vol)	No. of Reps	Mean Cell Density	T Statistic	Significance
Growth Medium	3	1259000		
10	3	1197000	1.673	
18	3	1147000	3.023	*
32	3	1029000	6.216	*
56	3	831000	11.551	*
100	3	489333	20.772	*

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.50).

APPENDIX 10

CLADOCERAN ACUTE AND 7-DAY SURVIVAL AND REPRODUCTION TEST CONDUCTED ON J-FIELD SW-12 SURFACE WATER (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static renewal (every 24 h)
Date:	April 30- May 7, 1997
Investigator:	S.D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-12
Chemical Characteristics:	See Appendix 21
Dilution Water:	
Source:	20% Perrier:80% RO water
Chemical Characteristics:	See Table A10-1
Test Organism:	
Scientific Name:	Ceriodaphnia dubia
Age at Start of Test:	<4 h
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	50 mL glass beaker
Test Solution Volume:	25 mL
No. Organisms/Replicate:	1
No. Organisms/Treatment:	10
Loading:	1 organism/beaker
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to each renewal
Endpoints:	Mortality of adults; number of neonates produced in 3 broods

Test Temperature:	25 ± 0.2°C
Water Quality:	Table A10-1

Results:

Mortality:

48-h Exposure:

The data for the 48-h LC50 were obtained from the 7-d study. All organisms survived during the 48-h exposure to all of the SW-12 surface water treatments (Table A10-2). A 48-h LC50 could not be determined.

7-d Exposure:

All organisms survived during the 7-d exposure to all of the SW-12 surface water treatments (Table A10-3). A 7-d LC50 could not be determined.

Neonate Production:

J-Field SW-12 surface water significantly reduced neonate production at all concentrations down to 32% surface water by volume after 7 d of exposure (Tables A10-3, A10-4 and A10-5).

The NOEC AND LOEC for the cladocerans, based on reduced neonate production, are as follows:

NOEC = 18% surface water by volume
LOEC = 32% surface water by volume

TABLE A10-1. SUMMARY OF THE J-FIELD SW-12 SURFACE WATER BIOASSAY WATER QUALITY DATA FOR THE CLADOCERAN 7-DAY TEST (HIGH AQUIFER FLOW) - DISSOLVED OXYGEN (MG/L)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	8.3	8.2	8.2	8.2	7.8	7.5
Day 1						
0 H	8.3	7.8	8.0	7.9	7.7	7.6
24 H	8.3	8.2	8.0	7.6	7.8	7.8
Day 2						
0 H	8.3	8.1	8.3	8.0	8.1	8.2
24 H	8.2	8.3	8.3	8.3	8.3	8.2
Day 3						
0 H	8.3	8.0	8.2	8.0	8.0	8.1
24 H	8.2	8.1	8.2	8.2	8.2	8.0
Day 4						
0 H	8.3	8.1	8.1	8.0	8.0	8.0
24 H	8.3	8.2	8.2	8.1	8.1	8.0
Day 5						
0 H	8.3	8.1	8.1	8.1	7.9	7.9
24 H	8.2	8.0	8.0	8.0	8.0	7.8
Day 6						
0 H	8.3	8.1	8.0	8.0	8.0	7.8
24 H	8.3	8.1	8.1	8.0	8.1	7.8
Day 7						
24 H	8.2	8.0	8.0	8.1	8.2	8.0

TABLE A10-1. (CONTINUED) - pH (STANDARD UNITS)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.44	7.24	7.33	7.31	7.25	7.10
Day 1						
0 H	7.35	7.40	7.42	7.43	7.50	7.03
24 H	7.28	7.47	7.59	7.73	7.86	7.97
Day 2						
0 H	7.33	7.45	7.47	7.49	7.53	7.28
24 H	7.45	8.06	8.10	8.16	8.18	8.21
Day 3						
0 H	7.40	7.43	7.40	7.44	7.49	7.20
24 H	7.59	8.02	8.08	8.11	8.14	8.18
Day 4						
0 H	7.37	7.41	7.39	7.47	7.55	7.15
24 H	7.60	7.99	8.02	8.09	8.00	8.00
Day 5						
0 H	7.31	7.24	7.15	7.39	7.36	7.11
24 H	7.69	7.89	7.96	7.91	7.99	7.95
Day 6						
0 H	7.39	7.20	7.12	7.33	7.41	7.17
24 H	7.65	7.91	7.91	7.95	7.96	8.02
Day 7						
24 H	7.61	7.97	7.99	8.01	8.06	8.08

TABLE A10-1. (CONTINUED) - CONDUCTIVITY (μMHOS/CM)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	180	580
Day 1		
0 H	180	600
Day 2		
0 H	180	600
Day 3		
0 H	190	590
Day 4		
0 H	190	580
Day 5		
0 H	180	590
Day 6		
0 H	190	600
Day 7		
24 H	180	600

TABLE A10-1. (CONTINUED) - ALKALINITY (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	55	145
Day 1		
0 H	50	150
Day 2		
0 H	55	150
Day 3		
0 H	50	140
Day 4		
0 H	55	145
Day 5		
0 H	55	150
Day 6		
0 H	50	150
Day 7		
24 H	60	160

TABLE A10-1. (CONTINUED) - HARDNESS (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	50	110
Day 1		
0 H	50	110
Day 2		
0 H	52	100
Day 3		
0 H	54	110
Day 4		
0 H	50	100
Day 5		
0 H	54	110
Day 6		
0 H	50	110
Day 7		
24 H	58	114

TABLE A10-2. CLADOCERAN J-FIELD SW-12 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL AFTER 48 HOURS OF EXPOSURE

Conc (% by Vol)	Number Tested	No. Alive at 48 Hours	Percent Alive
UMD/WREC Control	10	10	100
10	10	10	100
18	10	10	100
32	10	10	100
56	10	10	100
100	10	10	100

TABLE A10-3. CLADOCERAN J-FIELD SW-12 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW)- SURVIVAL OF ADULTS, TOTAL NUMBER OF YOUNG, AND NUMBER OF YOUNG PRODUCED PER BROOD AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	Rep	Brood No. 1	Brood No. 2	Brood No. 3	Total Young
UMD/WREC Control	1	4	8	15	27
	2	4	9	11	24
	3	4	8	12	24
	4	5	8	13	26
	5	4	7	14	25
	6	3	9	13	25
	7	3	10	13	26
	8	3	9	12	24
	9	3	7	12	22
	10	4	8	14	26
10	1	3	7	13	23
	2	5	8	14	27
	3	3	9	16	28
	4	2	8	15	25
	5	3	7	14	24
	6	3	9	12	24
	7	2	9	12	23
	8	3	7	14	24
	9	4	7	12	23
	10	3	9	10	22
18	1	3	8	12	23
	2	2	7	10	19
	3	6	8	14	28
	4	2	7	15	24
	5	8	8	5	21
	6	0	7	14	21
	7	4	7	14	25
	8	3	8	9	20
	9	3	7	14	24
	10	4	4	15	23

TABLE A10-3. (CONTINUED)

Conc (% by Vol)	Rep	Brood No. 1	Brood No. 2	Brood No. 3	Total Young
32	1	3	9	14	26
	2	4	13	7	24
	3	3	8	10	21
	4	3	6	10	19
	5	4	6	11	21
	6	3	4	9	16
	7	0	7	13	20
	8	3	8	9	20
	9	2	6	9	17
	10	3	5	13	21
56	1	2	4	14	20
	2	5	4	13	22
	3	3	10	0	13
	4	3	10	6	19
	5	3	5	13	21
	6	3	7	15	25
	7	3	8	13	24
	8	4	3	8	15
	9	7	5	16	28
	10	3	4	9	16
100	1	2	10	11	23
	2	3	7	11	21
	3	2	7	12	21
	4	3	8	12	23
	5	2	1	8	11
	6	4	9	9	22
	7	1	7	13	21
	8	2	5	11	18
	9	5	11	0	16
	10	3	6	13	22

TABLE A10-4. CLADOCERAN J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - NEONATE PRODUCTION AFTER 7 DAYS OF EXPOSURE

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

This test could not be performed because total number of replicates was greater than 50.

Chi-square Test for Normality:

Calculated test statistic:	0.31
Alpha value:	0.01
Critical value:	13.28
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	14.82
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	5.01
Alpha value:	0.05
Critical value:	2.45
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A10-5
Alpha value:	0.05
Critical value:	2.31
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A10-5. CLADOCERAN J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON NEONATE PRODUCTION AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Neonate Production	T Statistic	Significance
UMD/WREC Control	10	24.9		
10	10	24.3	0.431	
18	10	22.8	1.509	
32	10	20.5	3.162	*
56	10	20.3	3.306	*
100	10	19.8	3.665	*

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.31).

APPENDIX 11

FATHEAD MINNOW ACUTE AND 7-DAY SURVIVAL AND GROWTH TEST CONDUCTED ON J-FIELD SW-12 SURFACE WATER (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static renewal (every 24 h)
Date:	April 30- May 7, 1997
Investigator:	S.D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-12
Chemical Characteristics:	See Appendix 21
Dilution Water:	
Source:	20% Perrier:80% RO water
Chemical Characteristics:	See Table A11-1
Test Organism:	
Scientific Name:	Pimephales promelas
Dry Weight:	0.47 mg (mean weight of controls at end of test)
Age at Start of Test:	<24 h
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	600 mL glass beaker
Test Solution Volume:	400 mL
No. Organisms/Replicate:	10
No. Organisms/Treatment:	40
Loading:	<0.5 g/L
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to each renewal

Test Temperature:	25 ± 0.2°C
Endpoints:	Mortality; growth
Water Quality:	Table A11-1

Results:

Mortality:

96-h Exposure:

The data for the 96-h LC50 were obtained from the 7-d study. Fifty percent mortality occurred in the organisms exposed to 100% surface water for 96-h (Table A11-2). Less mortality occurred at the lower treatments. A 96-h LC50 could not be determined because mortality >50% did not occur.

7-d Exposure:

Significant (α = 0.05) mortality occurred in fathead minnow larvae exposed to all concentrations down to 32% surface water by volume for 7 d (Tables A11-3, A11-4, and A11-5). The 7-d LC50, which was determined by the Trimmed Spearman-Karber method, is as follows:

7-d LC50 = 90.8% surface water by volume (95% confidence limits = 54.08-152.43)

The NOEC and LOEC for the larval fish, based on mortality are as follows:

NOEC = 18% surface water by volume.
LOEC = 32% surface water by volume.

Growth:

The growth of fathead minnow larvae was not affected (α = 0.05) by a 7-d exposure to 18% or 10% surface water by volume (Tables A11-3, A11-6 and A11-7). Data from the 100%, 56% and 32% surface water by volume treatments was not included in the statistical analysis for larval growth because significant mortality occurred in these treatments.

TABLE A11-1. SUMMARY OF THE J-FIELD SW-12 SURFACE WATER BIOASSAY WATER QUALITY DATA FOR THE FATHEAD MINNOW 7-DAY TEST (HIGH AQUIFER FLOW) - DISSOLVED OXYGEN (MG/L)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	8.3	8.2	8.2	8.2	7.8	7.5
Day 1						
0 H	8.3	7.8	8.0	7.9	7.7	7.6
24 H	8.1	7.9	7.9	7.7	7.6	7.6
Day 2						
0 H	8.3	8.1	8.3	8.0	8.1	8.2
24 H	8.3	7.5	7.8	7.6	7.5	7.6
Day 3						
0 H	8.3	8.0	8.2	8.0	8.0	8.1
24 H	8.1	7.7	7.7	7.6	7.5	7.7
Day 4						
0 H	8.3	8.1	8.1	8.0	8.0	8.0
24 H	8.1	7.9	7.7	7.5	7.4	7.5
Day 5						
0 H	8.3	8.1	8.1	8.1	7.9	7.9
24 H	8.1	7.8	7.7	7.6	7.4	7.4
Day 6						
0 H	8.3	8.1	8.0	8.0	8.0	7.8
24 H	8.0	7.7	7.6	7.5	7.3	7.3
Day 7						
24 H	8.0	7.8	7.5	7.4	7.4	7.2

TABLE A11-1. (CONTINUED) - pH (STANDARD UNITS)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.44	7.24	7.33	7.31	7.25	7.10
Day 1						
0 H	7.35	7.40	7.42	7.43	7.50	7.03
24 H	7.57	7.70	7.72	7.77	7.85	7.95
Day 2						
0 H	7.33	7.45	7.47	7.49	7.53	7.28
24 H	7.74	7.77	7.77	7.76	7.86	7.97
Day 3						
0 H	7.40	7.43	7.40	7.44	7.49	7.20
24 H	7.67	7.71	7.67	7.80	7.89	7.99
Day 4						
0 H	7.37	7.41	7.39	7.47	7.55	7.15
24 H	7.61	7.65	7.70	7.77	7.80	7.89
Day 5						
0 H	7.31	7.24	7.15	7.39	7.36	7.11
24 H	7.70	7.69	7.65	7.85	7.79	7.85
Day 6						
0 H	7.39	7.20	7.12	7.33	7.41	7.15
24 H	7.65	7.71	7.60	7.76	7.84	7.80
Day 7						
24 H	7.69	7.75	7.73	7.81	7.87	7.90

TABLE A11-1. (CONTINUED) - CONDUCTIVITY (μMHOS/CM)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	180	580
Day 1		
0 H	180	600
Day 2		
0 H	180	600
Day 3		
0 H	190	590
Day 4		
0 H	190	580
Day 5		
0 H	180	590
Day 6		
0 H	190	600
Day 7		
24 H	200	600

TABLE A11-1. (CONTINUED) - ALKALINITY (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	55	145
Day 1		
0 H	50	150
Day 2		
0 H	55	150
Day 3		
0 H	50	140
Day 4		
0 H	55	145
Day 5		
0 H	55	150
Day 6		
0 H	50	150
Day 7		
24 H	55	155

TABLE A11-1. (CONTINUED) - HARDNESS (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Surface Water by Volume)	
	0	100
Day 0		
0 H	50	110
Day 1		
0 H	50	110
Day 2		
0 H	52	100
Day 3		
0 H	54	110
Day 4		
0 H	50	100
Day 5		
0 H	54	110
Day 6		
0 H	50	110
Day 7		
24 H	54	114

TABLE A11-2. FATHEAD MINNOW J-FIELD SW-12 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL AFTER 96 HOURS OF EXPOSURE

Concentration (% by Vol)	Rep	Number Tested	No. Alive at 96 Hours	Percent Alive
UMD/WREC Control	A	10	10	100
	B	10	10	100
	C	10	10	100
	D	10	10	100
10	A	10	10	100
	B	10	9	90
	C	10	8	80
	D	10	8	80
18	A	10	10	100
	B	10	10	100
	C	10	9	90
	D	10	10	100
32	A	10	8	80
	B	10	6	60
	C	10	9	90
	D	10	8	80
56	A	10	5	50
	B	10	6	60
	C	10	8	80
	D	10	7	70
100	A	10	4	40
	B	10	6	60
	C	10	6	60
	D	10	4	40

TABLE A11-3. FATHEAD MINNOW J-FIELD SW-12 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - LARVAL SURVIVAL AND GROWTH AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	Rep	Number Larvae Alive	Percent Survival	Dry Weight[a] (mg)	Mean Dry Weight (mg)
UMD/WREC Control	1	10	100	0.425	
	2	9	90	0.506	
	3	10	100	0.405	
	4	10	100	0.544	0.470
10	1	10	100	0.410	
	2	9	90	0.511	
	3	8	80	0.478	
	4	8	80	0.498	0.474
18	1	10	100	0.408	
	2	9	90	0.417	
	3	7	70	0.363	
	4	9	90	0.418	0.402
32	1	8	80	0.368	
	2	6	60	0.281	
	3	8	80	0.392	
	4	8	80	0.397	0.360
56	1	5	50	0.241	
	2	5	50	0.245	
	3	8	80	0.361	
	4	7	70	0.383	0.308
100	1	4	40	0.183	
	2	5	50	0.143	
	3	6	60	0.201	
	4	4	40	0.222	0.187

[a] Dry weight = Total dry weight of larvae/number of original larvae (10).

TABLE A11-4. FATHEAD MINNOW J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - SURVIVAL OF LARVAE AFTER 7 DAYS OF EXPOSURE

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.94
Alpha value:	0.01
Critical value:	0.88
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	2.26
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	11.62
Alpha value:	0.05
Critical value:	2.77
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A11-5
Alpha value:	0.05
Critical value:	2.41
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A11-5. FATHEAD MINNOW J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON LARVAL SURVIVAL AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Survival (%)[a]	T Statistic	Significance
UMD/WREC Control	4	97.5		
10	4	87.5	1.630	
18	4	87.5	1.561	
32	4	75.0	3.416	*
56	4	62.5	4.855	*
100	4	47.5	6.535	*

[a] Values given are actual percent survival means rather than arc sine square root transformed means which were used in the statistical analysis.

* Significantly different at alpha = 0.05 (Dunnett's Critical value = 2.41).

TABLE A11-6. FATHEAD MINNOW J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - DRY WEIGHT OF LARVAE AFTER 7 DAYS OF EXPOSURE[a]

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.93
Alpha value:	0.01
Critical value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	2.02
Alpha value:	0.01
Critical value:	9.21
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	2.84
Alpha value:	0.05
Critical value:	4.26
Conclusion:	Fail to reject the null hypothesis that all groups are equal

[a] The 100%, 56% and 32% surface water by volume treatments were not included in the statistical analysis for growth because there was significant mortality at these treatments.

APPENDIX 12

FROG EMBRYO TERATOGENESIS ASSAY - Xenopus (FETAX)
CONDUCTED ON J-FIELD SW-12 SURFACE WATER
(HIGH AQUIFER FLOW)

Test Method:	ASTM Designation E 1439-91 ASTM (1991)
Type of Test:	Static renewal (every 24 h)
Date:	May 2-6, 1997
Investigator:	S. D. Turley
Laboratory:	UMD/WREC
Surface Water:	
Source:	APG-EA J-Field SW-12
Chemical Characteristics:	See Appendix 21
Test Medium:	
Source:	FETAX solution
pH characteristics:	See Table A12-1
Test Organism:	
Scientific Name:	Xenopus laevis
Age at Start of Test:	Stage 8 blastula to stage 11 gastrulae
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	Glass petri dishes
Test Solution Volume:	10 mL
No. Organisms/Replicate:	25
No. Organisms/Treatment:	Control: 50 Surface water: 50
Loading:	n/a
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to renewals

Endpoints:	Mortality; malformation
Test Temperature:	24 ± 0.1°C

Results:

Mortality:

Embryo survival was not affected by exposure for 4 days to SW-12 surface water (Tables A12-2 and A12-3).

Malformations:

Significant (α = 0.05) embryo malformations occurred in the SW-12 treatments of 100% and 56% surface water by volume (Tables A12-2, A12-4, and A12-5). An EC50 for malformations could not be determined because less than 50% malformations occurred in any of the treatments. The NOEC and LOEC for the embryos, based on increased numbers of malformations, are as follows:

NOEC = 32% surface water by volume.
LOEC = 56% surface water by volume.

The types of malformed embryos are given in Table A12-7.

TABLE A12-1. SUMMARY OF THE J-FIELD SW-12 SURFACE WATER BIOASSAY pH (STANDARD UNITS) DATA FOR FETAX (HIGH AQUIFER FLOW)

	Test Concentrations (Percent Surface Water by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.47	7.56	7.57	7.60	7.61	7.28
Day 1						
0 H	7.51	7.55	7.51	7.54	7.57	7.20
Day 2						
0 H	7.49	7.52	7.49	7.46	7.51	7.15
Day 3						
0 H	7.45	7.37	7.29	7.38	7.33	7.11

TABLE A12-2. FETAX J-FIELD SW-12 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - PERCENT EMBRYO SURVIVAL AND MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Number Embryos Alive	Percent Survival	Number Embryos Malformed	Percent Malformed
UMD/WREC Control	1	25	100	2	8.0
	2	24	96	1	4.2
10	1	23	92	2	8.7
	2	25	100	1	4.0
18	1	24	96	2	8.3
	2	23	92	1	4.3
32	1	23	92	2	8.7
	2	23	92	3	13.0
56	1	22	88	3	13.6
	2	23	92	5	21.7
100	1	23	92	6	26.1
	2	21	84	6	28.6

TABLE A12-3. FETAX J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - PERCENT EMBRYO SURVIVAL AFTER 96 HOURS OF EXPOSURE

Data Transformation:

Arc-sine square-root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.97
Alpha value:	0.01
Critical value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed.

Bartlett's Test for Homogeneity of Variances:

Test could not be performed because at least one group had zero variance.

Fisher's Exact Test:

Calculated test statistic:	44-48
Alpha value:	0.05
Critical value:	43
Conclusion:	Fail to reject the null hypothesis that all groups are equal

TABLE A12 4. FETAX J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - PERCENT EMBRYO MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.85
Alpha value:	0.01
Critical Value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	1.12
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	9.25
Alpha value:	0.05
Critical value:	4.39
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A12-5
Alpha value:	0.05
Critical value:	2.83
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A12-5. FETAX J-FIELD SW-12 SURFACE WATER TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON EMBRYO MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Normal Embryos (%)[a]	T Statistic	Significance
UMD/WREC Control	2	93.9		
10	2	93.6	0.066	
18	2	93.7	0.069	
32	2	89.1	1.516	
56	2	82.4	3.195	*
100	2	72.6	5.256	*

[a] Values given are actual percent normal embryo means rather than arc sine square root transformed means which were used in the statistical analysis.

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.83).

TABLE A12-7. FETAX J-FIELD SW-12 SURFACE WATER TOXICITY TEST DATA (HIGH AQUIFER FLOW) - TYPE AND NUMBER OF MALFORMED EMBRYOS AFTER 96 HOURS OF EXPOSURE

Malformation	Test Concentrations (% Surface Water by Volume)											
	0		10		18		32		56		100	
	Rep		Rep		Rep		Rep		Rep		Rep	
	1	2	1	2	1	2	1	2	1	2	1	2
Severe							1		1		1	
Gut, coiling	1	1	1		2	1	1		1	2	3	3
Edema:												
Multiple			1	1			1	1	2	2		
Cardiac											1	1
Abdominal												
Facial												
Cephalic												
Blisters												
Tail												
Notochord	1						1				1	
Fin												
Face											1	1
Eye												
Brain												
Hemorrhage												
Cardiac												
Other												

APPENDIX 13

GREEN ALGAE 96-H GROWTH TEST CONDUCTED ON J-FIELD GROUNDWATER (WELL JF8-3) (HIGH AQUIFER FLOW) (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static non-renewal
Date:	May 3-7, 1997
Investigator:	S. D. Turley
Laboratory:	UMD/WREC
Groundwater:	
Source:	APG-EA J-Field Well JF8-3
Chemical Characteristics:	See Appendix 22
Test Medium:	Stock culture medium
Test Organism:	
Scientific Name:	Selenastrum capricornutum
Age at Start of Test:	Log growth
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	250 mL glass culture flasks with cheesecloth/cotton stoppers
Test Solution Volume:	100 mL
Initial Cell Density:	≈1 x 10^4 cells/mL
No. Replicates per Treatment:	3
Lighting:	Fluorescent; cool white; continuous; ≈300 foot candles
Shaking Rate:	100 cpm continuously
Endpoint:	Reduction in growth relative to control
Test Temperature:	25 ± 0.2 °C

Results:

Significant (α = 0.05) reductions in growth (cell density) occurred at all concentrations down to 18% groundwater by volume (Tables A13-1, A13-2, and A13-3). Growth was not affected by exposure to 10% groundwater by volume. The 100% groundwater by volume treatment was not included in the statistical analysis because all algal cells were killed after 48 hours of exposure. The NOEC and LOEC for reduction in growth are as follows:

NOEC = 10% groundwater by volume.
LOEC = 18% groundwater by volume.

The 96-h EC50 (reduction in growth), which was determined by the Trimmed Spearman-Karber method, is as follows:

96-h EC50 = 39.1% groundwater by volume (95% confidence limits = 35.51-43.02).

TABLE A13-1. GREEN ALGAL J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST DATA (HIGH AQUIFER FLOW)- MEAN CELL DENSITY (CELLS/ML) AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Mean Cell Density	
		0H	96H
Growth Medium	1	11000	1257000
	2	11000	1203000
	3	11000	1317000
10	1	11000	1169000
	2	11000	1246000
	3	11000	1224000
18	1	11000	1103000
	2	11000	1091000
	3	11000	1067000
32	1	11000	802000
	2	11000	804000
	3	11000	752000
56	1	11000	453000
	2	11000	412000
	3	11000	530000
100	1	11000	DEAD
	2	11000	DEAD
	3	11000	DEAD

Table A13-2. GREEN ALGAL J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - MEAN CELL DENSITY (CELLS/ML)[a]

Data Transformation:	
None	
Shapiro-Wilk's Test for Normality:	
Calculated test statistic:	0.96
Alpha value:	0.01
Critical value:	0.84
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed
Bartlett's Test for Homogeneity of Variances:	
Calculated test statistic:	2.66
Alpha value:	0.01
Critical value:	13.28
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous
ANOVA:	
Calculated test statistic:	173.43
Alpha value:	0.05
Critical value:	3.48
Conclusion:	Reject the null hypothesis that all groups are equal
Dunnett's Test:	
Calculated test statistic:	See Table A13-3
Alpha value:	0.05
Critical Value:	2.47
Conclusion:	Reject the null hypothesis that all groups are equal

[a] The 100% groundwater treatment was not included in the statistical analysis because all cells died at this treatment.

Table A13-3. GREEN ALGAL J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON MEAN CELL DENSITY (CELLS/ML)

Conc (% by Vol)	No. of Reps	Mean Cell Density	T Statistic	Significance
Growth Medium	3	1259000		
10	3	1213000	1.285	
18	3	1087000	4.803	*
32	3	786000	13.208	*
56	3	465000	22.172	*

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.47).

APPENDIX 14

CLADOCERAN ACUTE AND 7-DAY SURVIVAL AND REPRODUCTION TEST CONDUCTED ON J-FIELD GROUNDWATER (WELL JF8-3) (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static renewal (every 24 h)
Date:	May 2-9, 1997
Investigator:	S.D. Turley
Laboratory:	UMD/WREC
Groundwater:	
Source:	APG-EA J-Field Well JF8-3
Chemical Characteristics:	See Appendix 22
Dilution Water:	
Source:	20% Perrier:80% RO water
Chemical Characteristics:	See Table A14-1
Test Organism:	
Scientific Name:	Ceriodaphnia dubia
Age at Start of Test:	<4 h
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	50 mL glass beaker
Test Solution Volume:	25 mL
No. Organisms/Replicate:	1
No. Organisms/Treatment:	10
Loading:	1 organism/beaker
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to each renewal
Endpoints:	Mortality of adults; number of neonates produced in 3 broods

Test Temperature:	25 ± 0.0°C
Water Quality:	Table A14-1

Results:

Mortality:

48-h Exposure:

The data for the 48-h LC50 were obtained from the 7-d study. All of the organisms exposed to 100% groundwater by volume died during the 48-h exposure; 70% or less of the organisms exposed the lower treatments died during the 48-h exposure (Table A14-2). The 48-h LC50, determined by the Trimmed Spearman-Karber method, is as follows:

48-h LC50 = 40.0% groundwater by volume (95% confidence limits = 30.88-51.72)

7-d Exposure:

Significant (α = 0.05) mortality occurred in adults exposed to all concentrations down to 32% groundwater by volume for 7-d (See Tables A14-3, A14-4 and A14-5). The 7-d LC50, determined by the Trimmed Spearman-Karber method, is as follows:

7-d LC50 = 35.7% groundwater by volume (95% confidence limits = 27.30-46.63).

The NOEC and LOEC for the cladocerans, based on mortality after 7 d of exposure, are as follows:

NOEC = 18% groundwater by volume
LOEC = 32% groundwater by volume

Neonate Production:

A significant (α = 0.05) reduction in neonate production occurred at 18% groundwater water by volume after 7 d of exposure (Tables A14-3, A14-6 and A14-7) to J-Field groundwater taken from well JF8-3.

The NOEC and LOEC for the cladocerans, based on reduced neonate production, are as follows:

NOEC = 10% groundwater by volume
LOEC = 18% groundwater by volume

TABLE A14-1. SUMMARY OF THE J-FIELD GROUNDWATER (WELL JF8-3) BIOASSAY WATER QUALITY DATA FOR THE CLADOCERAN 7-DAY TEST (HIGH AQUIFER FLOW) - DISSOLVED OXYGEN (MG/L)

	Test Concentrations (Percent Groundwater by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	8.3	8.1	8.0	7.5	7.5	7.3
Day 1						
0 H	8.3	8.1	8.0	7.7	7.6	7.2
24 H	8.3	7.6	7.5	7.5	7.3	6.8
Day 2						
0 H	8.3	8.0	8.1	7.8	7.7	7.4
24 H	8.1	7.5	7.6	7.6	7.5	7.2
Day 3						
0 H	8.3	8.0	8.0	7.6	7.5	7.2[a]
24 H	8.2	7.5	7.7	7.3	7.4	
Day 4						
0 H	8.3	8.0	8.0	7.7	7.6	7.1[a]
24 H	8.3	7.4	7.7	7.4	7.3	
Day 5						
0 H	8.3	8.1	8.1	7.8	7.5	7.2[a]
24 H	8.1	7.5	7.6	7.2	7.2	
Day 6						
0 H	8.3	8.0	8.0	7.6	7.4	7.1[a]
24 H	8.2	7.7	7.5	7.0	7.0	
Day 7						
24 H	8.1	7.6	7.3	7.1	7.1	[a]

[a] No renewals performed. All organisms were dead.

TABLE A14-1. (CONTINUED) - pH (STANDARD UNITS)

	Test Concentrations (Percent Groundwater by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.33	7.20	7.07	6.98	6.57	6.03
Day 1						
0 H	7.40	7.23	7.03	7.00	6.60	6.08
24 H	7.59	7.37	7.40	7.17	6.90	6.79
Day 2						
0 H	7.37	7.30	7.00	6.89	6.53	6.00
24 H	7.51	7.40	7.43	7.21	7.03	7.01
Day 3						
0 H	7.31	7.15	7.03	6.92	6.57	6.05
24 H	7.69	7.37	7.29	7.24	7.07	[a]
Day 4						
0 H	7.39	7.18	6.99	6.96	6.51	6.00
24 H	7.65	7.33	7.33	7.19	7.01	[a]
Day 5						
0 H	7.36	7.23	7.05	6.91	6.55	5.99
24 H	7.60	7.49	7.42	7.23	7.15	[a]
Day 6						
0 H	7.40	7.29	7.12	7.01	6.65	6.03
24 H	7.67	7.55	7.49	7.35	7.02	[a]
Day 7						
24 H	7.60	7.44	7.37	7.26	6.98	[a]

[a] No renewals performed. All organisms were dead.

TABLE A14-1. (CONTINUED) - CONDUCTIVITY (μMHOS/CM)

	Test Concentrations (Percent Groundwater by Volume)	
	0	100
Day 0		
0 H	180	440
Day 1		
0 H	190	450
Day 2		
0 H	190	440
Day 3		
0 H	180	460
Day 4		
0 H	190	440
Day 5		
0 H	180	450
Day 6		
0 H	190	430
Day 7		
24 H	190	[a]

[a] No renewals performed. All organisms were dead.

TABLE A14-1. (CONTINUED) - ALKALINITY (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Groundwater by Volume)	
	0	100
Day 0		
0 H	55	180
Day 1		
0 H	50	190
Day 2		
0 H	55	190
Day 3		
0 H	55	190
Day 4		
0 H	50	200
Day 5		
0 H	50	190
Day 6		
0 H	55	190
Day 7		
24 H	50	[a]

[a] No renewals performed. All organisms were dead.

TABLE A14-1. (CONTINUED) - HARDNESS (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Groundwater by Volume)	
	0	100
Day 0		
0 H	52	125
Day 1		
0 H	54	130
Day 2		
0 H	50	130
Day 3		
0 H	54	120
Day 4		
0 H	50	130
Day 5		
0 H	50	120
Day 6		
0 H	50	130
Day 7		
24 H	54	[a]

[a] No renewals performed. All organisms were dead.

TABLE A14-2. CLADOCERAN J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL AFTER 48 HOURS OF EXPOSURE

Concentration (% by Vol)	Number Tested	No. Alive at 48 Hours	Percent Alive
UMD/WREC Control	10	10	100
10	10	10	100
18	10	9	90
32	10	7	70
56	10	3	30
100	10	0	00

TABLE A14-3. CLADOCERAN J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL OF ADULTS, TOTAL NUMBER OF YOUNG, AND NUMBER OF YOUNG PRODUCED PER BROOD AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	Rep	Brood No. 1	Brood No. 2	Brood No. 3	Total Young
UMD/WREC Control	1	3	9	12	24
	2	4	7	14	25
	3	4	7	15	26
	4	4	7	14	25
	5	5	10	13	28
	6	3	7	16	26
	7	4	10	10	24
	8	3	7	12	22
	9	4	6	14	24
	10	4	8	12	24
10	1	3	8	11	22
	2	5	8	11	24
	3	6	7	12	25
	4	5	9	12	26
	5	5	8	11	24
	6	3	6	12	21
	7	4	6	12	22
	8	5	9	12	26
	9	4	9	10	23
	10	4	7	14	25
18	1	4	7	7	18
	2	3	4	8	15
	3	3	9	7	19
	4	3	11	11	25
	5	2	7	8	17
	6	3	5	10	18
	7	4	5	6	15
	8	Dead			
	9	4	7	10	21
	10	2	4	9	15

TABLE A14-3. (CONTINUED)

Conc (% by Vol)	Rep	Brood No. 1	Brood No. 2	Brood No. 3	Total Young
32	1	0	4	7	11
	2	2	Dead		2
	3	Dead			
	4	2	3	0	5
	5	4	3	9	16
	6	Dead			
	7	Dead			
	8	0	4	6	10
	9	0	Dead		0
	10	0	3	5	8
56	1	Dead			
	2	Dead			
	3	Dead			
	4	Dead			
	5	Dead			
	6	Dead			
	7	Dead			
	8	0	0	0	0
	9	0	0	1	1
	10	0	1	2	3
100	1	Dead			
	2	Dead			
	3	Dead			
	4	Dead			
	5	Dead			
	6	Dead			
	7	Dead			
	8	Dead			
	9	Dead			
	10	Dead			

TABLE A14-4. CLADOCERAN J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - ADULT SURVIVAL AFTER 7 DAYS OF EXPOSURE

Data Transformation:

None

Fisher's Exact Test:

Calculated test statistic:	See Table A14-5
Alpha value:	0.05
Critical value:	6
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A14-5. CLADOCERAN J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF FISHER'S EXACT TEST ON ADULT SURVIVAL AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	Number Alive	Number Dead	b Value	Significance
UMD/WREC Control	10	0		
10	10	0	10	
18	9	1	9	
32	5	5	5	*
56	3	7	3	*
100	0	10	0	*

* Significantly different at alpha = 0.05 (Fisher's critical value = 6).

TABLE A14-6. CLADOCERAN J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - NEONATE PRODUCTION AFTER 7 DAYS OF EXPOSURE[a]

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.76
Alpha value:	0.01
Critical value:	0.90
Conclusion:	Reject the null hypothesis that the data are normally distributed

Steel's Many-One Rank Test:

Calculated test statistic:	See Table A14-7
Alpha value:	0.05
Critical value:	79.00
Conclusion:	Reject the null hypothesis that all groups are equal

[a] The 100%, 56%, and 32% groundwater by volume treatments were excluded from the statistical analysis on neonate production because significant mortality occurred in these treatments.

TABLE A14-7. CLADOCERAN J-FIELD GROUNDWATER (WELL JF-8) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF STEEL'S MANY-ONE RANK TEST ON NEONATE PRODUCTION AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Neonate Production	Rank Sum	Critical Value	Significance
UMD/WREC Control	10	24.8			
10	10	23.8	91.00	79.00	
18	10	16.3	61.00	79.00	*

* Significantly different at alpha = 0.05.

APPENDIX 15

FATHEAD MINNOW ACUTE AND 7-DAY SURVIVAL AND GROWTH TEST CONDUCTED ON J-FIELD GROUNDWATER (WELL JF8-3) (HIGH AQUIFER FLOW)

Test Method:	EPA/600/4-91/002 (Lewis et al., 1994)
Type of Test:	Static renewal (every 24 h)
Date:	May 2-9, 1997
Investigator:	S.D. Turley
Laboratory:	UMD/WREC
Groundwater:	
Source:	APG-EA J-Field Well JF8-3
Chemical Characteristics:	See Appendix 22
Dilution Water:	
Source:	20% Perrier:80% RO water
Chemical Characteristics:	See Table A15-1
Test Organism:	
Scientific Name:	Pimephales promelas
Dry Weight:	0.35 mg (mean weight of controls at end of test)
Age at Start of Test:	<24 h
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	600 mL glass beaker
Test Solution Volume:	400 mL
No. Organisms/Replicate:	10
No. Organisms/Treatment:	40
Loading:	<0.5 g/L
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to each renewal

Endpoints:	Mortality; growth
Test Temperature:	25 ± 0.0°C
Water Quality:	Table A15-1

Results:

Mortality:

96-h Exposure:

The data for the 96-h LC50 were obtained from the 7-d study. All of the organisms exposed to all concentrations down to 18% groundwater by volume died during the 96-h exposure; 7.5 and 5% of the organisms exposed to 10% and 5.6% groundwater, respectively, died during the 96-h exposure (Table A15-2). The 96-h LC50, which was determined by the Trimmed Spearman-Karber method, is as follows:

96-h LC50 = 13.0% groundwater by volume (95% confidence limits = 12.26- 13.78)

7-d Exposure:

Significant (α = 0.05) mortality occurred in fathead minnow larvae exposed to all concentrations down to 18% groundwater by volume for 7 d (Tables A15-3, A15-4, and A15-5). The 7-d LC50, which was determined by the Trimmed Spearman-Karber method, is as follows:

7-d LC50 = 12.8% groundwater by volume (95% confidence limits = 11.98-13.65)

The NOEC and LOEC for the larval fish, based on mortality, are as follows:

NOEC = 10% groundwater by volume.
LOEC = 18% groundwater by volume.

Growth:

The growth of fathead minnow larvae was not affected (α = 0.05) by a 7-d exposure to 10% or 5.6% groundwater by volume (Tables A15-3, A15-6 and A15-7). Data from the 18%, 32%, 56% and 100% groundwater by volume treatments were not included in the statistical analysis for larval growth because significant mortality occurred in these treatments.

TABLE A15-1. SUMMARY OF THE J-FIELD GROUNDWATER (WELL JF8-3) BIOASSAY WATER QUALITY DATA FOR THE FATHEAD MINNOW 7-DAY TEST (HIGH AQUIFER FLOW) - DISSOLVED OXYGEN (MG/L)

	Test Concentrations (Percent Groundwater by Volume)						
	0	5.6	10	18	32	56	100
Day 0							
0 H	8.3	8.1	8.0	8.0	7.5	7.5	7.3
Day 1							
0 H	8.3	8.1	8.0	8.0	7.7	7.6	7.2
24 H	8.3	8.0	7.7	7.5	7.2	7.1	6.4
Day 2							
0 H	8.3	8.2	8.0	8.0	7.8	7.7	7.4
24 H	8.1	8.1	7.8	[a]	[a]	[a]	[a]
Day 3							
0 H	8.3	8.1	8.1	8.1	7.6	7.5	7.2
24 H	8.1	8.0	7.6	[a]	[a]	[a]	[a]
Day 4							
0 H	8.3	8.2	8.1	8.1	7.7	7.6	7.1
24 H	8.0	8.1	7.5	[a]	[a]	[a]	[a]
Day 5							
0 H	8.3	8.0	8.1	8.1	7.8	7.5	7.2
24 H	8.1	8.0	7.4	[a]	[a]	[a]	[a]
Day 6							
0 H	8.3	8.2	8.0	8.0	7.6	7.4	7.1
24 H	8.0	8.0	7.3	[a]	[a]	[a]	[a]
Day 7							
24 H	7.9	8.1	7.1	[a]	[a]	[a]	[a]

[a] No renewals performed. All organisms were dead.

TABLE A15-1. (CONTINUED) - pH (STANDARD UNITS)

	Test Concentrations (Percent Groundwater by Volume)						
	0	5.6	10	18	32	56	100
Day 0							
0 H	7.33	7.29	7.20	7.07	6.98	6.57	6.03
Day 1							
0 H	7.40	7.37	7.23	7.03	7.00	6.60	6.08
24 H	7.59	7.37	7.29	7.55	7.48	7.32	6.56
Day 2							
0 H	7.37	7.32	7.30	7.00	6.89	6.53	6.00
24 H	7.51	7.45	7.40	[a]	[a]	[a]	[a]
Day 3							
0 H	7.31	7.27	7.24	7.03	6.92	6.57	6.05
24 H	7.70	7.34	7.36	[a]	[a]	[a]	[a]
Day 4							
0 H	7.39	7.35	7.20	6.99	6.96	6.51	6.00
24 H	7.65	7.40	7.45	[a]	[a]	[a]	[a]
Day 5							
0 H	7.36	7.31	7.23	7.05	6.91	6.55	5.99
24 H	7.60	7.37	7.35	[a]	[a]	[a]	[a]
Day 6							
0 H	7.40	7.38	7.29	7.12	7.01	6.65	6.03
24 H	7.69	7.49	7.41	[a]	[a]	[a]	[a]
Day 7							
24 H	7.73	7.53	7.33	[a]	[a]	[a]	[a]

[a] No renewals performed. All organisms were dead.

TABLE A15-1. (CONTINUED) - CONDUCTIVITY (μMHOS/CM)

	Test Concentrations (Percent Groundwater by Volume)	
	0	100
Day 0		
0 H	180	440
Day 1		
0 H	190	450
Day 2		
0 H	190	440
Day 3		
0 H	180	460
Day 4		
0 H	190	440
Day 5		
0 H	180	450
Day 6		
0 H	190	430
Day 7		
24 H	190	[a]

[a] No renewals performed. All organisms were dead.

TABLE A15-1. (CONTINUED) - ALKALINITY (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Groundwater by Volume)	
	0	100
Day 0		
0 H	55	180
Day 1		
0 H	50	190
Day 2		
0 H	55	190
Day 3		
0 H	55	190
Day 4		
0 H	50	200
Day 5		
0 H	50	190
Day 6		
0 H	55	190
Day 7		
24 H	50	[a]

[a] No renewals performed. All organisms were dead.

TABLE A15-1. (CONTINUED) - HARDNESS (MG/L AS $CaCO_3$)

	Test Concentrations (Percent Groundwater by Volume)	
	0	100
Day 0		
0 H	52	125
Day 1		
0 H	54	130
Day 2		
0 H	50	130
Day 3		
0 H	54	120
Day 4		
0 H	50	130
Day 5		
0 H	50	120
Day 6		
0 H	50	130
Day 7		
24 H	54	[a]

[a] No renewals performed. All organisms were dead.

TABLE A15-2. FATHEAD MINNOW J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST DATA (HIGH AQUIFER FLOW) - SURVIVAL AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Number Tested	No. Alive at 96 Hours	Percent Alive
UMD/WREC Control	A	10	10	100
	B	10	10	100
	C	10	10	100
	D	10	9	90
5.6	A	10	10	100
	B	10	9	90
	C	10	10	100
	D	10	9	90
10	A	10	9	90
	B	10	10	100
	C	10	10	100
	D	10	8	80
18	A	10	0	00
	B	10	0	00
	C	10	0	00
	D	10	0	00
32	A	10	0	00
	B	10	0	00
	C	10	0	00
	D	10	0	00
56	A	10	0	00
	B	10	0	00
	C	10	0	00
	D	10	0	00
100	A	10	0	00
	B	10	0	00
	C	10	0	00
	D	10	0	00

TABLE A15-3. FATHEAD MINNOW J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST DATA (HIGH AQUIFER FLOW) - LARVAL SURVIVAL AND GROWTH AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	Rep	Number Larvae Alive	Percent Survival	Dry Weight[a] (mg)	Mean Dry Weight (mg)
UMD/WREC Control	1	10	100	0.345	
	2	9	90	0.321	
	3	10	100	0.379	
	4	9	90	0.359	0.351
5.6	1	10	100	0.371	
	2	9	90	0.318	
	3	10	100	0.359	
	4	9	90	0.326	0.344
10	1	9	90	0.325	
	2	10	100	0.382	
	3	10	100	0.394	
	4	7	70	0.304	0.351
18	1	0	0		
	2	0	0		
	3	0	0		
	4	0	0		
32	1	0	0		
	2	0	0		
	3	0	0		
	4	0	0		
56	1	0	0		
	2	0	0		
	3	0	0		
	4	0	0		
100	1	0	0		
	2	0	0		
	3	0	0		
	4	0	0		

[a] Dry weight = Total dry weight of larvae/number of original larvae (10).

TABLE A15-4. FATHEAD MINNOW J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - SURVIVAL OF LARVAE AFTER 7 DAYS OF EXPOSURE

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.81
Alpha value:	0.01
Critical value:	0.90
Conclusion:	Reject the null hypothesis that the data are normally distributed

Steel's Many-One Rank Test:

Calculated test statistic:	See Table A15-5
Alpha value:	0.05
Critical value:	10.00
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A15-5. FATHEAD MINNOW J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF STEEL'S MANY-ONE RANK TEST ON LARVAL SURVIVAL AFTER 7 DAYS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Survival (%)[a]	Rank Sum	Critical Value	Significance
UMD/WREC Control	4	95.0			
10	4	95.0	18.00	10.00	
18	4	90.0	17.00	10.00	*
32	4	0.0	10.00	10.00	*
56	4	0.0	10.00	10.00	*
100	4	0.0	10.00	10.00	*

[a] Values given are actual percent survival means rather than arc sine square root transformed means which were used in the statistical analysis.

* Significantly different at alpha = 0.05.

TABLE A15-6. FATHEAD MINNOW J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - DRY WEIGHT OF LARVAE AFTER 7 DAYS OF EXPOSURE[a]

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.94
Alpha value:	0.01
Critical value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	1.17
Alpha value:	0.01
Critical value:	9.21
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	0.07
Alpha value:	0.05
Critical value:	4.26
Conclusion:	Fail to reject the null hypothesis that all groups are equal

[a] The 100%, 56%, 32%, and 18% groundwater by volume treatments were not included in the statistical analysis on larval growth because significant mortality occurred at these treatments.

APPENDIX 16

FROG EMBRYO TERATOGENESIS ASSAY - Xenopus (FETAX)
CONDUCTED ON J-FIELD GROUNDWATER (WELL JF8-3)
(HIGH AQUIFER FLOW)

Test Method:	ASTM Designation E 1439-91 ASTM (1991)
Type of Test:	Static renewal (every 24 h)
Date:	May 5-9, 1997
Investigator:	S. D. Turley
Laboratory:	UMD/WREC
Groundwater:	
Source:	APG-EA J-Field Well JF8-3
Chemical Characteristics:	See Appendix 22
Test Medium:	
Source:	FETAX solution
pH characteristics:	See Table A16-1
Test Organism:	
Scientific Name:	Xenopus laevis
Age at Start of Test:	Stage 8 blastula to stage 11 gastrulae
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	Glass petri dishes
Test Solution Volume:	10 mL
No. Organisms/Replicate:	25
No. Organisms/Treatment:	Control: 50 Groundwater: 50
Loading:	n/a
Lighting:	Fluorescent; 60-85 foot candles
Aeration:	Prior to renewals

Endpoints:	Mortality; malformation
Test Temperature:	24 ± 0.2°C

Results:

Mortality:

Less than 50% mortality occurred to the embryos exposed for 4 days to 100% groundwater by volume; thus, a LC50 could not be calculated (Table A16-2). Embryo survival was, however, significantly ($\alpha = 0.05$) affected by exposure for 4 days to all concentrations down to 32% groundwater by volume (Tables A16-2, A16-3 and A16-4). The NOEC and LOEC for the embryos, based on embryo mortality, are as follows:

NOEC = 18% groundwater by volume
LOEC = 32% groundwater by volume

Malformations:

Malformations up to 90% occurred in the embryos exposed to 100% groundwater (Table A16-2). The 96-h EC50, which was determined by the Trimmed Spearman-Karber method, is as follows:

96-h EC50 = 52.0% groundwater by volume (95% confidence limits = 44.20-61.12)

Exposure for 4 days to 18% or 10% groundwater by volume did not affect the normal development of embryos (Tables A16-2 and A16-5). The 100%, 56% and 32% groundwater by volume treatments were not included in the statistical analysis for malformations because significant mortality occurred in these treatments.

The types of malformed embryos are given in Table A16-6.

TABLE A16-1. SUMMARY OF THE J-FIELD GROUNDWATER (WELL JF8-3) BIOASSAY pH (STANDARD UNITS) DATA FOR FETAX (HIGH AQUIFER FLOW)

	Test Concentrations (Percent Groundwater by Volume)					
	0	10	18	32	56	100
Day 0						
0 H	7.45	7.34	7.15	7.00	6.66	6.05
Day 1						
0 H	7.50	7.30	7.10	7.06	6.60	6.00
Day 2						
0 H	7.45	7.33	7.15	7.04	6.67	5.99
Day 3						
0 H	7.51	7.38	7.23	7.11	6.75	6.03

TABLE A16-2. FETAX J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST DATA (HIGH AQUIFER FLOW) - PERCENT EMBRYO SURVIVAL AND MALFORMATIONS AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	Rep	Number Embryos Alive	Percent Survival	Number Embryos Malformed	Percent Malformed
UMD/WREC Control	1	24	96	2	8.3
	2	25	100	1	4.0
10	1	24	96	2	8.3
	2	25	100	2	8.0
18	1	25	100	2	8.0
	2	24	96	4	16.7
32	1	21	84	3	14.3
	2	20	80	7	35.0
56	1	21	84	7	33.3
	2	20	80	11	55.0
100	1	15	60	13	86.7
	2	17	68	16	94.1

TABLE A16-3. FETAX J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - PERCENT EMBRYO SURVIVAL AFTER 96 HOURS OF EXPOSURE

Data Transformation:

Arc-sine square-root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.81
Alpha value:	0.01
Critical value:	0.81
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed.

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	0.66
Alpha value:	0.01
Critical value:	15.09
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	24.21
Alpha value:	0.05
Critical value:	4.39
Conclusion:	Reject the null hypothesis that all groups are equal

Dunnett's Test:

Calculated test statistic:	See Table A16-4
Alpha value:	0.05
Critical value:	2.83
Conclusion:	Reject the null hypothesis that all groups are equal

TABLE A16-4. FETAX J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF DUNNETT'S TEST ON EMBRYO SURVIVAL AFTER 96 HOURS OF EXPOSURE

Conc (% by Vol)	No. of Reps	Mean Survival (%)[a]	T Statistic	Significance
UMD/WREC Control	2	98.0		
10	2	98.0	0.000	
18	2	98.0	0.000	
32	2	82.0	4.785	*
56	2	82.0	4.785	*
100	2	64.0	8.211	*

[a] Values given are actual percent survival means rather than arc sine square root transformed means which were used in the statistical analysis.

* Significantly different at alpha = 0.05 (Dunnett's critical value = 2.83).

TABLE A16-5. FETAX J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - PERCENT EMBRYO MALFORMATIONS AFTER 96 HOURS OF EXPOSURE[a]

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.96
Alpha value:	0.01
Critical Value:	0.71
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	3.47
Alpha value:	0.01
Critical value:	9.21
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	1.33
Alpha value:	0.05
Critical value:	9.55
Conclusion:	Fail to reject the null hypothesis that all groups are equal

[a] The 100%, 56%, and 32% groundwater water by volume treatments were not included in the statistical analysis for malformations because there was significant mortality at these treatments.

TABLE A16-6. FETAX J-FIELD GROUNDWATER (WELL JF8-3) TOXICITY TEST DATA (HIGH AQUIFER FLOW) - TYPE AND NUMBER OF MALFORMED EMBRYOS AFTER 96 HOURS OF EXPOSURE

Malformation	Test Concentrations (% Groundwater by Volume)											
	0		10		18		32		56		100	
	Rep		Rep		Rep		Rep		Rep		Rep	
	1	2	1	2	1	2	1	2	1	2	1	2
Severe									1		1	1
Gut, coiling	1	1	2	1	2	2	3	5	2	5	1	8
Edema:												
Multiple	1		1		2		2		5	5	11	7
Cardiac												
Abdominal Facial												
Cephalic												
Blisters												
Tail												
Notochord												
Fin												
Face												
Eye												
Brain												
Hemorrhage												
Cardiac												
Other												

APPENDIX 17

AMPHIPOD 28-DAY PARTIAL LIFE CYCLE TOXICITY TEST CONDUCTED ON J-FIELD SW-11 AND SOUTH BEACH SEDIMENTS (HIGH AQUIFER FLOW)

Test Method:	Ingersoll and Nelson (1990)
Type of Test:	Static renewal (3x per week)
Date:	May 21, 1997 - June 18, 1997
Investigator:	S. D. Turley
Laboratory:	UMD/WREC
Sediment:	
Experimental:	J-Field SW-11 and South Beach
Reference:	UMD/WREC (Magothy River)
Chemical Characteristics:	See Appendices 20 and 23
Test Organism:	
Scientific Name:	Hyalella azteca
Age at Start of Test:	5-10 d
Source:	UMD/WREC culture
Experimental Chambers:	
Material:	1 L Glass beaker
Water:sediment Ratio:	800 mL:200 mL (v/v)
Overlying Water:	UMD/WREC non-chlorinated deep well water supplemented with filtered estuarine water (salinity <0.5‰)
Renewal of Overlying Water:	0.5 Volume renewal 3x per week
No. Replicates per Treatment:	5
No. Organisms per Replicate:	20
Feeding:	Yeast cerophyl trout chow (YCT) 3x per week; 3.0 mL for days 1-14; 5.0 mL for days 15-28

Aeration:	1-2 Bubbles/sec with a 1 mL glass pipette
Lighting:	16L:8D (Fluorescent; 60-85 foot candles)
Endpoints:	Survival, growth as estimated by length, and sexual maturation of females
Test Acceptability:	80% Control survival
Overlying Water Quality:	See Table A17-1

Results:

Survival:

Amphipod survival was not affected for organisms exposed for 28 d to sediments taken from SW-11 and South Beach (Tables A17-2 and A17-4).

Growth:

The growth of H. azteca was not affected by a 28-d exposure to sediments taken from SW-11 and South Beach (Tables A17-2 and A17-5).

Reproduction:

The reproduction of female amphipods was not affected by a 28-d exposure to sediments taken from SW-11 and South Beach (Tables A17-3, A17-6, and A17-7).

TABLE A17-1. SUMMARY OF THE J-FIELD SW-11 AND SOUTH BEACH SEDIMENT BIOASSAY OVERLYING WATER QUALITY DATA FOR THE AMPHIPOD 28-DAY TOXICITY TEST (HIGH AQUIFER FLOW) - TEMPERATURE (°C)

Day	UMD/WREC Control	SW-11	South Beach
0	25.3	25.3	25.2
1	25.1	25.1	25.1
2	25.1	25.1	25.2
3	25.1	25.1	25.1
4	25.1	25.1	25.1
5	24.5	24.5	24.5
6	24.0	24.0	24.0
7	24.0	24.0	24.0
8	25.1	25.1	25.1
9	25.1	25.1	25.1
10	25.0	25.0	25.0
11	25.0	25.0	25.0
12	24.9	24.9	24.9
13	25.0	25.0	25.0
14	24.8	24.8	24.8
15	25.0	25.0	25.0
16	25.0	25.0	25.0
17	25.0	25.0	25.0
18	24.8	24.8	24.8
19	24.8	24.8	24.8
20	25.0	25.0	25.0
21	25.0	25.0	25.0
22	25.0	25.0	25.0
23	25.0	25.0	25.0
24	25.0	25.0	25.0
25	25.0	25.0	25.0
26	25.0	25.0	25.0
27	25.0	25.0	25.1
28	25.0	25.0	25.0
Mean	24.9	24.9	24.9
Min	24.0	24.0	24.0
Max	25.3	25.3	25.2

TABLE A17-1. (CONTINUED) - DISSOLVED OXYGEN (MG/L)

Day	UMD/WREC Control	SW-11	South Beach
0	7.6	7.2	7.6
1	7.5	7.0	7.4
2	7.4	7.2	7.3
3	7.4	7.4	7.5
4	7.5	7.6	7.5
5	7.6	7.5	7.8
6	7.7	7.6	7.7
7	7.3	7.0	7.2
8	7.6	7.5	7.6
9	7.6	7.6	7.7
10	7.5	7.5	7.3
11	7.4	7.5	7.4
12	7.7	7.4	7.5
13	7.4	7.6	7.5
14	7.7	7.7	7.6
15	7.5	7.6	7.5
16	7.6	7.6	7.6
17	7.5	7.6	7.4
18	7.3	7.4	7.3
19	7.8	7.7	7.8
20	7.0	7.1	7.0
21	7.4	7.3	7.3
22	7.3	7.5	7.3
23	7.8	7.8	7.7
24	7.6	7.5	7.3
25	7.4	7.6	7.3
26	7.5	7.5	7.4
27	7.4	7.5	7.3
28	7.5	7.6	7.4
Mean	7.5	7.5	7.5
Min	7.0	7.0	7.0
Max	7.8	7.8	7.8

TABLE A17-1. (CONTINUED) - pH (STANDARD UNITS)

Day	UMD/WREC Control	SW-11	South Beach
0	7.71	7.49	7.78
1			
2	8.14	8.10	8.30
3			
4			
5	8.14	8.29	8.37
6			
7	7.92	7.76	7.94
8			
9	8.02	7.90	7.91
10			
11			
12	8.16	7.80	7.92
13			
14	8.20	7.91	7.87
15			
16	8.17	7.95	7.96
17			
18			
19	8.11	7.92	7.88
20			
21	8.05	7.96	7.84
22			
23	8.05	7.95	7.92
24			
25			
26	8.07	7.95	7.86
27			
28	8.10	7.99	7.93
Min	7.71	7.49	7.78
Max	8.20	8.29	8.37

TABLE A17-1. (CONTINUED) - CONDUCTIVITY (μMHOS/CM)

Day	UMD/WREC Control	SW-11	South Beach
0	1000	800	900
1			
2	1200	800	1000
3			
4			
5	1000	800	900
6			
7	800	800	800
8			
9	980	890	900
10			
11			
12	1000	900	900
13			
14	1000	900	980
15			
16	1100	1000	1080
17			
18			
19	1000	900	900
20			
21	800	800	700
22			
23	800	700	700
24			
25			
26	800	850	700
27			
28	850	850	800
Mean	948	845	866
Min	800	700	700
Max	1200	1000	1080

Table A17-2. AMPHIPOD SEDIMENT BIOASSAY SURVIVAL AND GROWTH (LENGTH IN MM) AFTER 28 DAYS OF EXPOSURE (HIGH AQUIFER FLOW) - UMD/WREC CONTROL

Number of Test Organisms	Rep No. 1	Rep No. 2	Rep No. 3	Rep No. 4	Rep No. 5
1	4.1	3.0	3.1	3.7	3.8
2	4.0	3.2	3.7	3.5	3.3
3	3.7	3.4	3.6	3.4	3.5
4	4.0	3.5	3.2	3.2	3.2
5	4.1	3.3	3.4	3.5	3.3
6	3.3	3.4	3.9	2.7	3.2
7	3.5	3.4	3.0	3.4	3.5
8	4.0	3.1	3.5	3.6	3.0
9	3.4	2.9	3.4	3.6	3.2
10	3.5	3.4	3.4	3.4	3.7
11	3.3	3.0	3.2	3.3	3.3
12	3.2	2.9	2.9	3.4	3.2
13	3.3	3.3	3.7	3.3	3.3
14	3.2	3.4	3.5	3.4	3.4
15	3.5	2.9	3.4	3.3	3.2
16	3.0	3.2	3.5	3.5	2.9
17	3.3	3.3	3.3	3.1	3.3
18	3.4	DEAD	3.6	3.3	2.9
19	3.4	DEAD	3.5	3.2	3.3
20	3.4	DEAD	DEAD	DEAD	DEAD
Mean	3.5	3.2	3.4	3.4	3.3
Min	3.0	2.9	2.9	2.7	2.9
Max	4.1	3.5	3.9	3.7	3.8

Table A17-2. (CONTINUED) - SW-11

Number of Test Organisms	Rep No. 1	Rep No. 2	Rep No. 3	Rep No. 4	Rep No. 5
1	4.1	3.4	4.0	3.8	3.3
2	3.7	3.5	3.2	3.1	3.5
3	3.6	4.0	3.2	3.5	3.3
4	3.3	3.6	3.6	4.0	3.0
5	3.2	3.4	3.5	3.7	3.3
6	3.3	3.4	3.3	3.5	3.4
7	3.2	2.7	3.5	3.5	3.6
8	3.2	3.6	3.2	3.5	3.2
9	3.0	3.5	3.4	3.6	3.1
10	3.4	3.7	3.1	3.2	3.7
11	3.3	3.2	3.2	4.0	4.0
12	3.8	3.6	2.8	3.0	3.3
13	2.6	3.3	3.0	3.1	3.9
14	3.1	3.5	3.7	3.1	3.4
15	4.0	4.0	3.0	3.2	3.3
16	3.6	3.7	3.0	3.0	3.3
17	3.5	3.3	3.3	3.1	3.5
18	3.4	3.1	3.0	3.2	3.5
19	DEAD	3.3	3.7	3.4	DEAD
20	DEAD	3.5	3.0	DEAD	DEAD
Mean	3.4	3.5	3.3	3.4	3.4
Min	2.6	2.7	2.8	3.0	3.0
Max	4.1	4.0	4.0	4.0	4.0

Table A17-2. (CONTINUED) - SOUTH BEACH

Number of Test Organisms	Rep No. 1	Rep No. 2	Rep No. 3	Rep No. 4	Rep No. 5
1	3.9	3.0	3.6	3.9	3.2
2	3.0	3.2	3.5	3.6	3.3
3	3.0	3.5	3.6	3.9	3.4
4	3.1	3.5	3.2	3.7	3.7
5	3.5	3.9	4.0	3.6	3.5
6	3.0	3.0	3.6	3.2	3.0
7	3.6	3.2	2.9	3.2	3.3
8	3.2	3.2	3.1	3.3	3.2
9	3.0	3.1	3.9	3.2	3.2
10	3.8	3.1	3.2	3.3	3.2
11	3.4	3.5	3.1	3.3	3.3
12	2.9	3.0	3.5	3.4	3.4
13	3.1	3.3	3.3	3.2	3.2
14	3.2	3.3	3.4	3.3	3.4
15	3.2	3.2	3.2	3.5	3.3
16	3.1	3.4	3.0	3.3	3.7
17	3.2	3.2	3.4	3.6	3.3
18	3.1	3.2	3.2	3.4	3.0
19	DEAD	3.0	3.4	3.6	3.2
20	DEAD	3.2	3.3	3.3	3.2
Mean	3.2	3.3	3.4	3.4	3.3
Min	2.9	3.0	2.9	3.2	3.0
Max	3.9	3.9	4.0	3.9	3.7

Table A17-3. NUMBER OF GRAVID AND TOTAL NUMBER OF FEMALE AMPHIPODS IN THE J-FIELD SW-11 AND SOUTH BEACH SEDIMENT BIOASSAYS AFTER 28 DAYS OF EXPOSURE (HIGH AQUIFER FLOW)

	Replicate No. 1		Replicate No. 2		Replicate No. 3		Replicate No. 4		Replicate No. 5	
	No. Gravid	Total No.	No. Gravid	Total No.	No. Gravid	Total No.	No. Gravid	Total No.	No. Gravid	Total No.
UMD/WREC Control	6	10	4	7	4	7	6	11	5	9
SW-11	5	7	4	9	6	9	6	9	7	12
South Beach	3	9	7	11	8	11	7	12	7	13

Table A17-4. AMPHIPOD J-FIELD SW-11 AND SOUTH BEACH SEDIMENT BIOASSAY STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - ADULT SURVIVAL AFTER 28 DAYS OF EXPOSURE

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.91
Alpha value:	0.01
Critical value:	0.84
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	0.05
Alpha value:	0.01
Critical value:	9.21
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	1.01
Alpha value:	0.05
Critical value:	3.89
Conclusion:	Fail to reject the null hypothesis that all groups are equal

Table A17-6. AMPHIPOD J-FIELD SW-11 AND SOUTH BEACH SEDIMENT BIOASSAY STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - ADULT GROWTH AFTER 28 DAYS OF EXPOSURE

Data Transformation:

None

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.97
Alpha value:	0.01
Critical value:	0.84
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	0.87
Alpha value:	0.01
Critical value:	9.21
Conclusion:	Fail to reject the null hypothesis that the variances are homogenous

ANOVA:

Calculated test statistic:	0.96
Alpha value:	0.05
Critical value:	3.89
Conclusion:	Fail to reject the null hypothesis that all groups are equal

Table A17-7. AMPHIPOD J-FIELD SW-11 AND SOUTH BEACH SEDIMENT BIOASSAY STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - GRAVID FEMALES AFTER 28 DAYS OF EXPOSURE

Data Transformation:

Arc sine square root

Shapiro-Wilk's Test for Normality:

Calculated test statistic:	0.91
Alpha value:	0.01
Critical value:	0.84
Conclusion:	Fail to reject the null hypothesis that the data are normally distributed

Bartlett's Test for Homogeneity of Variances:

Calculated test statistic:	9.36
Alpha value:	0.01
Critical value:	9.21
Conclusion:	Reject the null hypothesis that the variances are homogenous

Steel's Many-One Rank Test:

Calculated test statistic:	See Table A17-8
Alpha value:	0.05
Critical value:	18.00
Conclusion:	Fail to reject the null hypothesis that all groups are equal

Table A17-8. AMPHIPOD J-FIELD SW-11 AND SOUTH BEACH SEDIMENT BIOASSAY STATISTICAL ANALYSIS (HIGH AQUIFER FLOW) - RESULTS OF STEEL'S MANY-ONE RANK TEST ON GRAVID FEMALES AFTER 28 DAYS OF EXPOSURE

Station	No. of Reps	Mean Gravid (%)[a]	Rank Sum	Critical Value	Significance
UMD/WREC Control	5	56.9			
SW-11	5	61.5	34.00	18.00	
South Beach	5	56.3	29.00	18.00	

[a] Values given are actual percent gravid female means rather than arc sine square root transformed means which were used in the statistical analysis.

APPENDIX 18

COMPREHENSIVE CHEMICAL AND MUNITIONS ANALYSES CONDUCTED ON SURFACE WATER FROM J-FIELD SW-10 (HIGH AQUIFER FLOW)

Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

(410) 633-1600
(800) GAS-COY
FAX NO
(410) 633-5444

REPORT OF ANALYSIS

Report No. 9700826-A

Report Date: June 18, 1997

Report To: U.S. Army

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Sample I.D. Submitted Water: APG-J-Field, ~~Site 12~~ SW-10, Grab, dated 05/07/97

Compound	Results	Detection Limits
Chloromethane	<10	10
Bromomethane	<10	10
Vinyl chloride	57	10
Chloroethane	<10	10
Methylene chloride	<5	5
Acrolein	<100	100
Acrylonitrile	<100	100
Trichlorofluoromethane	<5	5
1,1-Dichloroethane	<5	5
trans-1,2-Dichloroethene	94	5
Chloroform	<5	5
1,2-Dichloroethane	<5	5
1,1,1-Trichloroethane	<5	5
Carbon tetrachloride	<5	5
Bromodichloromethane	<5	5
1,2-Dichloropropane	<5	5
cis-1,3-Dichloropropene	<5	5
trans-1,3-Dichloropropene	<5	5
1,3-Dichloropropene	<5	5
Dibromochloromethane	<5	5
1,1,2-Trichloroethane	11	5
2-Chloroethylvinyl ether	<10	10
Bromoform	<5	5
Tetrachloroethene	<5	5
1,1,2,2-Tetrachloroethane (4)	230	5
Ethylbenzene	<5	5
1,1-Dichloroethene	<5	5
Trichloroethene	61	5
Benzene	<5	5
Toluene	<5	5
Chlorobenzene	<5	5
Total Xylenes	<10	10

Notes: (1) Results expressed as ug/l (ppb).
(2) Analysis performed according to method EPA 8260A.
(3) Analyst(s): TLN; Date Test Completed: 05/08/97.
(4) Reported results estimated; results outside of linear calibration range.

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Laboratory Director

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army

Sample I.D. Submitted Water: APG-J-Field, ~~Site 12~~ SW-10, Grab, dated 05/07/97

Pesticides/PCB's	Result	Detection Limit
a-BHC	<0.05	0.05
b-BHC	<0.05	0.05
g-BHC	<0.05	0.05
d-BHC	<0.05	0.05
Heptachlor	<0.05	0.05
Aldrin	<0.05	0.05
Heptachlor epoxide	<0.05	0.05
A-Endosulfan	<0.1	0.1
4,4'-DDE	<0.1	0.1
Dieldrin	<0.1	0.1
Endrin	<0.1	0.1
B-Endosulfan	<0.3	0.3
Endrin aldehyde	<0.3	0.3
4,4'-DDD	<0.3	0.3
Endosulfan sulfate	<0.3	0.3
4,4'-DDT	<0.3	0.3
PCB-1242	<1	1
PCB-1254	<1	1
PCB-1221	<1	1
PCB-1232	<1	1
PCB-1248	<1	1
PCB-1260	<1	1
PCB-1016	<1	1
Chlordane	<1	1
Toxaphene	<3	3

Notes: (1) Results expressed as ug/liter(ppb).
(2) Analyses were performed according to EPA Method 3510B/ 8080A.
(3) Analyst: GDM; Date Test Completed: 05/14/97.

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Laboratory Director

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 10 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 12~~ SW-10, Grab, dated 05/07/97

Herbicides	Result	Detection Limit
2,4-D	<0.5	0.5
2,4,5-TP (Silvex)	<0.2	0.2

Notes: (1) Results expresssed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method 8150B.
(3) Analyst: GDM; Date Test Completed: 05/13/97.

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army

Sample I.D. Submitted water: APG-U-Field, ~~Site 12~~ SW-10, Grab, dated 05/07/97

Acid Compounds	Result	Detection Limits
Phenol	<10	10
2-Chlorophenol	<10	10
2-Nitrophenol	<10	10
2,4-Dimethylphenol	<10	10
2,4-Dichlorophenol	<10	10
4-Chloro-3-methylphenol	<20	20
2,4,6-Trichlorophenol	<10	10
2,4-Dinitrophenol	<50	50
4-Nitrophenol	<50	50
4,6-Dinitro-2-methylphenol	<50	50
Pentachlorophenol	<50	50
Base/Neutral Compounds		
N-Nitrosodimethylamine	<10	10
bis(2-Chloroethyl)ether	<10	10
1,3-Dichlorobenzene	<10	10
1,4-Dichlorobenzene	<10	10
1,2-Dichlorobenzene	<10	10
bis(2-Chloroisopropyl)ether	<10	10
N-Nitroso-di-n-propylamine	<10	10
Hexachloroethane	<10	10
Nitrobenzene	<10	10
Isophorone	<10	10
bis(2-Chloroethoxy)methane	<10	10
1,2,4-Trichlorobenzene	<10	10
Naphthalene	<10	10
Hexachlorobutadiene	<10	10
Hexachlorocyclopentadiene	<10	10
2-Chloronaphthalene	<10	10
Dimethyl phthalate	<10	10
Acenaphthylene	<10	10

Notes: (1) Results expressed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method(s) 8270B.
(3) Analyst: DMJ; Date Test Completed: 05/28/97.

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Laboratory Director

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 12 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 12~~ SW-10, Grab, dated 05/07/97

Base/Neutral Compound	Result	Detection Limit
Acenaphthene	<10	10
2,4-Dinitrotoluene	<10	10
2,6-Dinitrotoluene	<10	10
Diethyl phthalate	<10	10
4-Chlorophenyl phenyl ether	<10	10
Fluorene	<10	10
N-Nitrosodiphenylamine (3)	<10	10
1,2 Diphenylhydrazine (4)	<10	10
Hexachlorobenzene	<10	10
Phenanthrene	<10	10
Anthracene	<10	10
Di-n-butyl phthalate	<10	10
Fluoranthene	<10	10
Pyrene	<10	10
Butyl benzyl phthalate	<10	10
3,3'Dichlorobenzidine	<20	20
Benzo(a)anthracene	<10	10
bis(2-Ethylhexyl)phthalate	<10	10
Chrysene	<10	10
Di-n-octyl phthalate	<10	10
Benzo(b)fluoranthene	<10	10
Benzo(k)fluoranthene	<10	10
Benzo(a)pyrene	<10	10
Indeno(1,2,3-cd)pyrene	<10	10
Dibenzo(a,h)anthracene	<10	10
Benzo(ghi)perylene	<10	10

Notes: (1) Results expressed as ug/liter (ppm).
(2) Analyses were performed according to EPA Method 8270.
(3) Cannot be separated from diphenylamine.
(4) Detected as azobenzene.
(5) Analyst: DMJ; Date Test Completed: 05/28/97.

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army

Sample I.D. Submitted Water: APG-J-Field, ~~Site 12~~ SW-10, Grab, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date Test Completed
Aluminum (Al)	0.3	0.1	EPA 6010A	PDB	05/22/97
Antimony (Sb)	<0.5	0.5	EPA 6010A	PDB	05/22/97
Arsenic (As)	<0.5	0.5	EPA 6010A	PDB	05/22/97
Beryllium (Be)	<0.005	0.005	EPA 6010A	PDB	05/22/97
Boron (B)	0.30	0.05	EPA 6010A	PDB	05/22/97
Cadmium (Cd)	<0.01	0.01	EPA 6010A	PDB	05/22/97
Calcium (Ca)	79	0.5	EPA 6010A	PDB	05/22/97
Chromium (Cr)	<0.02	0.02	EPA 6010A	PDB	05/22/97
Cobalt (Co)	<0.01	0.01	EPA 6010A	PDB	05/22/97
Copper (Cu)	<0.01	0.01	EPA 6010A	PDB	05/22/97
Hardness (CaCO3)	280	2	EPA 6010A	PDB	05/22/97
Iron (Fe)	4.9	0.1	EPA 6010A	PDB	05/22/97
Lead (Pb)	<0.1	0.1	EPA 6010A	PDB	05/22/97
Magnesium (Mg)	19	0.1	EPA 6010A	PDB	05/22/97
Manganese (Mn)	0.37	0.01	EPA 6010A	PDB	05/22/97
Mercury (Hg)	<0.0002	0.0002	EPA 7470A	MMM	05/22/97
Molybdenum (Mo)	<0.02	0.02	EPA 6010A	PDB	05/22/96
Nickel (Ni)	<0.02	0.02	EPA 6010A	PDB	05/22/96
Potassium (K)	3.6	0.1	EPA 6010A	PDB	05/22/96
Selenium (Se)	<0.005	0.005	EPA 7740	CJK	05/23/97
Silver (Ag)	<0.02	0.02	EPA 6010A	PDB	05/22/97
Sodium (Na)	54	0.5	EPA 6010A	PDB	05/22/97
Thallium (Tl)	<0.5	0.5	EPA 6010A	PDB	05/22/97
Tin (Sn)	<0.2	0.2	EPA 6010A	PDB	05/22/97
Zinc (Zn)	<0.02	0.02	EPA 6010A	PDB	05/22/97

Notes: (1) Results expressed as mg/l (ppm).

William L. Lock
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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 14 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 12~~ SW-10, Grab, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date T Comple
Alkalinity (CaCO3)	260	4	EPA 310.1	DMW	05/13
Ammonia (N)	<1	1	SM4500-NH3 E	RED	05/28
Bromide (Br)	0.53	0.05	EPA 9056	PBK	05/08
Chloride (Cl)	96	0.4	EPA 9056	PBK	05/16
Cyanide (CN), Total	<0.01	0.01	EPA 335.3	RED	05/11
Fluoride (F), Undistilled	0.27	0.05	EPA 9056	PBK	05/08
Nitrate (N)	<0.01	0.01	EPA 9056	PBK	05/08
Nitrite (N)	<0.01	0.01	EPA 9056	PBK	05/08
pH (2)	7.4	NA	EPA 9040B	TMV	05/07
Phosphorus (P), Total	0.20	0.01	SM4500-P E	DMW	05/16
Specific Conductance (3)	740	NA	EPA 9050	DMW	05/23
Sulfate (SO4)	12	0.2	EPA 9056	PBK	05/08
Sulfide (S), Total	<1	1	EPA 376.1	DMW	05/12
Total Organic Carbon	12	1	EPA 9060	RED	05/16
Total Suspended Solids	71	3	EPA 160.2	LAT	05/14

Notes: (1) Results expressed as mg/l (ppm).
(2) Results expressed as pH units.
(3) Results expressed as micromhos/cm.

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Laboratory Director

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Department of the Army
U.S. Army Biomedical Research and Development Laboratory
Research Methods Branch

ANALYTICAL CHEMISTRY REPORT

TEST NUMBER NA DATE REPORTED 5/20/97

ANALYSIS/MATRIX MUNITIONS / WATER

Collection Site	Date(s) Collected	Date(s) Analyzed
BRDL RM 7	5/15/97	5/15-5/19/97

Chemistry Accession Number	Sample Identification (SW-10)	Concentration - mg/L				
		Replicate 1	Replicate 2	Replicate 3	Mean	Std. Dev.
	J-Field ~~site 12~~ A					
	Surface Water					
97-1556	97-134-3					
	HMX	BDL	BDL	BDL	BDL	
	RDX	BDL	BDL	BDL	BDL	
	TNB	BDL	BDL	BDL	BDL	
	1,3-DNB	BDL	BDL	BDL	BDL	
	TETRYL	BDL	BDL	BDL	BDL	
	NB	BDL	BDL	BDL	BDL	
	TNT	BDL	BDL	BDL	BDL	
	4-AM-2,6-DNT	BDL	BDL	BDL	BDL	
	2-AM-4,6-DNT	BDL	BDL	BDL	BDL	
	2,6-DNT	BDL	BDL	BDL	BDL	
	2,4-DNT	BDL	BDL	BDL	BDL	
	2-NT	BDL	BDL	BDL	BDL	
	4-NT	BDL	BDL	BDL	BDL	
	3-NT	BDL	BDL	BDL	BDL	

The Detectable limit for this method is 50 ug/L

Comments:

Chemist [signature] Date 5/20/97

Reviewed by _____ Date _____

Form No. 46-4

APPENDIX 19

COMPREHENSIVE CHEMICAL AND MUNITIONS ANALYSES CONDUCTED ON SURFACE WATER FROM J-FIELD SW-11 (HIGH AQUIFER FLOW)

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 15 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 13~~ SW-11, Grab, dated 05/07/97

Compound	Results	Detection Limits
Chloromethane	<10	10
Bromomethane	<10	10
Vinyl chloride	<10	10
Chloroethane	<10	10
Methylene chloride	<5	5
Acrolein	<100	100
Acrylonitrile	<100	100
Trichlorofluoromethane	<5	5
1,1-Dichloroethane	<5	5
trans-1,2-Dichloroethene	<5	5
Chloroform	<5	5
1,2-Dichloroethane	<5	5
1,1,1-Trichloroethane	<5	5
Carbon tetrachloride	<5	5
Bromodichloromethane	<5	5
1,2-Dichloropropane	<5	5
cis-1,3-Dichloropropene	<5	5
trans-1,3-Dichloropropene	<5	5
1,3-Dichloropropene	<5	5
Dibromochloromethane	<5	5
1,1,2-Trichloroethane	<5	5
2-Chloroethylvinyl ether	<10	10
Bromoform	<5	5
Tetrachloroethene	<5	5
1,1,2,2-Tetrachloroethane	<5	5
Ethylbenzene	<5	5
1,1-Dichloroethene	<5	5
Trichloroethene	<5	5
Benzene	<5	5
Toluene	<5	5
Chlorobenzene	<5	5
Total Xylenes	<10	10

Notes: (1) Results expressed as ug/l (ppb).
(2) Analysis performed according to method EPA 8260A.
(3) Analyst(s): TLN; Date Test Completed: 05/09/97.

William L. Lock
Laboratory Director

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 16 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 13~~ SW-11, Grab, dated 05/07/97

Pesticides/PCB's	Result	Detection Limit
a-BHC	<0.05	0.05
b-BHC	<0.05	0.05
g-BHC (4)	<0.05	0.05
d-BHC	<0.05	0.05
Heptachlor (4)	<0.05	0.05
Aldrin (4)	<0.05	0.05
Heptachlor epoxide	<0.05	0.05
A-Endosulfan	<0.1	0.1
4,4'-DDE	<0.1	0.1
Dieldrin (4)	<0.1	0.1
Endrin	<0.1	0.1
B-Endosulfan	<0.3	0.3
Endrin aldehyde	<0.3	0.3
4,4'-DDD	<0.3	0.3
Endosulfan sulfate	<0.3	0.3
4,4'-DDT	<0.3	0.3
PCB-1242	<1	1
PCB-1254	<1	1
PCB-1221	<1	1
PCB-1232	<1	1
PCB-1248	<1	1
PCB-1260	<1	1
PCB-1016	<1	1
Chlordane	<1	1
Toxaphene	<3	3

Notes: (1) Results expressed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method 3510B/ 8080A.
(3) Analyst: GDM; Date Test Completed: 05/14/97.
(4) Reported result is estimated due to matrix spike recovery outside of acceptable limits.

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 17 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 13~~ SW-11, Grab, dated 05/07/97

Herbicides	Result	Detection Limit
2,4-D	<0.5	0.5
2,4,5-TP (Silvex)	<0.2	0.2

Notes: (1) Results expresssed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method 8150B.
(3) Analyst: GDM; Date Test Completed: 05/13/97.

William L. Lock
Laboratory Director

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 18 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 13~~ SW-11, Grab, dated 05/07/97

Acid Compounds	Result	Detection Limits
Phenol	<10	10
2-Chlorophenol	<10	10
2-Nitrophenol	<10	10
2,4-Dimethylphenol	<10	10
2,4-Dichlorophenol	<10	10
4-Chloro-3-methylphenol	<20	20
2,4,6-Trichlorophenol	<10	10
2,4-Dinitrophenol	<50	50
4-Nitrophenol	<50	50
4,6-Dinitro-2-methylphenol	<50	50
Pentachlorophenol	<50	50
Base/Neutral Compounds		
N-Nitrosodimethylamine	<10	10
bis(2-Chloroethyl)ether	<10	10
1,3-Dichlorobenzene	<10	10
1,4-Dichlorobenzene	<10	10
1,2-Dichlorobenzene	<10	10
bis(2-Chloroisopropyl)ether	<10	10
N-Nitroso-di-n-propylamine	<10	10
Hexachloroethane	<10	10
Nitrobenzene	<10	10
Isophorone	<10	10
bis(2-Chloroethoxy)methane	<10	10
1,2,4-Trichlorobenzene	<10	10
Naphthalene	<10	10
Hexachlorobutadiene	<10	10
Hexachlorocyclopentadiene	<10	10
2-Chloronaphthalene	<10	10
Dimethyl phthalate	<10	10
Acenaphthylene	<10	10

Notes: (1) Results expressed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method(s) 8270B.
(3) Analyst: DMJ; Date Test Completed: 05/28/97

William L. Lock
Laboratory Director

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 19 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 13~~ SW-11, Grab, dated 05/07/97

Base/Neutral Compound	Result	Detection Limit
Acenaphthene	<10	10
2,4-Dinitrotoluene	<10	10
2,6-Dinitrotoluene	<10	10
Diethyl phthalate	<10	10
4-Chlorophenyl phenyl ether	<10	10
Fluorene	<10	10
N-Nitrosodiphenylamine	<10	10
4-Bromophenyl phenyl ether	<10	10
Hexachlorobenzene	<10	10
Phenanthrene	<10	10
Anthracene	<10	10
Di-n-butyl phthalate	<10	10
Fluoranthene	<10	10
Pyrene	<10	10
Butyl benzyl phthalate	<10	10
3,3'Dichlorobenzidine	<20	20
Benzo(a)anthracene	<10	10
bis(2-Ethylhexyl)phthalate	<10	10
Chrysene	<10	10
Di-n-octyl phthalate	<10	10
Benzo(b)fluoranthene	<10	10
Benzo(k)fluoranthene	<10	10
Benzo(a)pyrene	<10	10
Indeno(1,2,3-cd)pyrene	<10	10
Dibenzo(a,h)anthracene	<10	10
Benzo(ghi)perylene	<10	10

Notes: (1) Results expressed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method 8270.
(3) Cannot be separated from diphenylamine.
(4) Analyst: DMJ; Date Test Completed: 05/28/97.

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 20 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 13~~ SW-11, Grab, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date Tes Complete
Aluminum (Al)	0.6	0.1	EPA 6010A	PDB	05/22/9
Antimony (Sb)	<0.5	0.5	EPA 6010A	PDB	05/22/9
Arsenic (As)	<0.5	0.5	EPA 6010A	PDB	05/22/9
Beryllium (Be)	<0.005	0.005	EPA 6010A	PDB	05/22/9
Boron (B)	0.17	0.05	EPA 6010A	PDB	05/22/9
Cadmium (Cd)	<0.01	0.01	EPA 6010A	PDB	05/22/9
Calcium (Ca)	42	0.5	EPA 6010A	PDB	05/22/9
Chromium (Cr)	<0.02	0.02	EPA 6010A	PDB	05/22/9
Cobalt (Co)	<0.01	0.01	EPA 6010A	PDB	05/22/9
Copper (Cu)	0.02	0.01	EPA 6010A	PDB	05/22/9
Hardness (CaCO3)	280	2	EPA 6010A	PDB	05/22/9
Iron (Fe)	10	0.1	EPA 6010A	PDB	05/22/9
Lead (Pb)	<0.1	0.1	EPA 6010A	PDB	05/22/9
Magnesium (Mg)	43	0.1	EPA 6010A	PDB	05/22/9
Manganese (Mn)	0.34	0.01	EPA 6010A	PDB	05/22/9
Mercury (Hg)	<0.0002	0.0002	EPA 7470A	MMM	05/22/9
Molybdenum (Mo)	<0.02	0.02	EPA 6010A	PDB	05/22/9
Nickel (Ni)	<0.02	0.02	EPA 6010A	PDB	05/22/9
Potassium (K)	7.2	0.1	EPA 6010A	PDB	05/22/9
Selenium (Se)	<0.005	0.005	EPA 7740	CJK	05/23/9
Silver (Ag)	<0.02	0.02	EPA 6010A	PDB	05/22/9
Sodium (Na)	74	0.5	EPA 6010A	PDB	05/22/9
Thallium (Tl)	<0.5	0.5	EPA 6010A	PDB	05/22/9
Tin (Sn)	<0.2	0.2	EPA 6010A	PDB	05/22/9
Zinc (Zn)	0.28	0.02	EPA 6010A	PDB	05/22/9

Notes: (1) Results expressed as mg/l (ppm).

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William L. Lock
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YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 21 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 13~~ SW-11, Grab, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date Test Completed
Alkalinity (CaCO3)	220	4	EPA 310.1	RED	05/13/97
Ammonia (N)	<1	1	SM4500-NH3 E	RED	05/28/97
Bromide	<0.5	0.5	EPA 9056	PBK	05/08/97
Chloride (Cl)	150	1.0	EPA 9056	PBK	05/16/97
Cyanide (CN), Total	<0.01	0.01	EPA 335.3	RED	05/11/97
Fluoride (F), Undistilled	0.13	0.05	EPA 9056	RED	05/08/97
Nitrate (N)	0.13	0.01	EPA 9056	PBK	05/08/97
Nitrite (N)	<0.01	0.01	EPA 9056	PBK	05/08/97
pH (2)	7.2	NA	EPA 9040B	TMV	05/07/97
Phosphorus (P), Total	0.35	0.01	SM4500-P E	DMW	05/16/97
Specific Conductance (3)	880	NA	EPA 9050	DMW	05/23/97
Sulfate (SO4)	6	0.2	EPA 9056	PBK	05/08/97
Sulfide (S), Total	<1	1	EPA 376.1	DMW	05/12/97
Total Organic Carbon	20	1	EPA 9060	RED	05/16/97
Total Suspended Solids	55	3	EPA 160.2	LAT	05/14/97

Notes: (1) Results expressed as mg/l (ppm).
(2) Results expressed as pH units.
(3) Results expressed as micromhos/cm.

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William L. Lock
Laboratory Director

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Department of the Army
U.S. Army Biomedical Research and Development Laboratory
Research Methods Branch

ANALYTICAL CHEMISTRY REPORT

TEST NUMBER NA DATE REPORTED 5/20/97

ANALYSIS/MATRIX MUNITIONS / WATER

Collection Site	Date(s) Collected	Date(s) Analyzed
BRDL RM 7	5/15/97	5/15-5/19/97

Chemistry Accession Number	Sample Identification (SW-11)	Concentration - mg/L				
		Replicate 1	Replicate 2	Replicate 3	Mean	Std. Dev.
	J-Field ~~site 13~~ h					
	Surface Water					
97-1557	97-134-4					
	HMX	BDL	BDL	BDL	BDL	
	RDX	BDL	BDL	BDL	BDL	
	TNB	BDL	BDL	BDL	BDL	
	1,3-DNB	BDL	BDL	BDL	BDL	
	TETRYL	BDL	BDL	BDL	BDL	
	NB	BDL	BDL	BDL	BDL	
	TNT	BDL	BDL	BDL	BDL	
	4-AM-2,6-DNT	BDL	BDL	BDL	BDL	
	2-AM-4,6-DNT	BDL	BDL	BDL	BDL	
	2,6-DNT	BDL	BDL	BDL	BDL	
	2,4-DNT	BDL	BDL	BDL	BDL	
	2-NT	BDL	BDL	BDL	BDL	
	4-NT	BDL	BDL	BDL	BDL	
	3-NT	BDL	BDL	BDL	BDL	

The Detectable limit for this method is 50 ug/L

Comments:

Chemist [signature] Date 5/20/97

Reviewed by _____ Date _____

Form No. 46-4

APPENDIX 20

COMPREHENSIVE CHEMICAL AND MUNITIONS ANALYSES CONDUCTED ON SURFICIAL SEDIMENT FROM J-FIELD SW-11 (HIGH AQUIFER FLOW)

Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 29 of 36

Sample I.D. Submitted Sludge: APG-J-Field, Sediment ~~Site 13~~ SW-11, Composite, dated 05/07/97

Compound	Results	Detection Limits
Chloromethane	<4.7	4.7
Bromomethane	<4.7	4.7
Vinyl chloride	<2.3	2.3
Chloroethane	<2.3	2.3
Methylene chloride	<2.3	2.3
Acrolein	<47	47
Acrylonitrile	<47	47
Trichlorofluoromethane	<2.3	2.3
1,1-Dichloroethane	<2.3	2.3
trans-1,2-Dichloroethene	<2.3	2.3
Chloroform	<2.3	2.3
1,2-Dichloroethane	<2.3	2.3
1,1,1-Trichloroethane	<2.3	2.3
Carbon tetrachloride	<2.3	2.3
Bromodichloromethane	<2.3	2.3
1,2-Dichloropropane	<2.3	2.3
cis-1,3-Dichloropropene	<2.3	2.3
trans-1,3-Dichloropropene	<2.3	2.3
1,3-Dichloropropene	<2.3	2.3
Dibromochloromethane	<2.3	2.3
1,1,2-Trichloroethane	<2.3	2.3
2-Chloroethylvinyl ether	<4.7	4.7
Bromoform	<2.3	2.3
Tetrachloroethene	<2.3	2.3
1,1,2,2-Tetrachloroethane	<2.3	2.3
Ethylbenzene	<2.3	2.3
1,1-Dichloroethene	<2.3	2.3
Trichloroethene	<2.3	2.3
Benzene	<2.3	2.3
Toluene	<2.3	2.3
Chlorobenzene	<2.3	2.3
Total Xylenes	<4.7	4.7

Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Analysis performed according to method EPA 8260A.
(3) Analyst(s): TLN; Date Test Completed: 05/13/97.

William L. Lock
Laboratory Director

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Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 30 of 36

Sample I.D. Submitted Sludge: APG-J-Field, Sediment ~~Site 13~~ SW-11, Composite, dated 05/07/97

Pesticides/PCB's	Result	Detection Limit
a-BHC	<0.2	0.2
b-BHC	<0.2	0.2
g-BHC	<0.2	0.2
d-BHC	<0.2	0.2
Heptachlor	<0.2	0.2
Aldrin	<0.2	0.2
Heptachlor epoxide	<0.2	0.2
A-Endosulfan	<0.5	0.5
4,4'-DDE	<0.5	0.5
Dieldrin	<0.5	0.5
Endrin	<0.5	0.5
B-Endosulfan	<1.4	1.4
Endrin aldehyde	<1.4	1.4
4,4'-DDD	<1.4	1.4
Endosulfan sulfate	<1.4	1.4
4,4'-DDT	<1.4	1.4
PCB-1242	<5	5
PCB-1254	<5	5
PCB-1221	<5	5
PCB-1232	<5	5
PCB-1248	<5	5
PCB-1260	<5	5
PCB-1016	<5	5
Chlordane	<5	5
Toxaphene	<14	14

Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Analyses were performed according to EPA Method 3550A/ 8080A.
(3) Analyst: GDM; Date Test Completed: 05/14/97.

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William L. Lock
Laboratory Director

Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 31 of 36

Sample I.D. Submitted Sludge: APG-J-Field, Sediment ~~Site 13~~ SW-11, Composite, dated 05/07/97

Herbicides	Result	Detection Limit
2,4-D	<0.2	0.2
2,4,5-TP (Silvex)	<0.09	0.09

Notes: (1) Results expresssed as mg/kg (ppm) on a dry weight basis.
(2) Analyses were performed according to EPA Method 8150B.
(3) Analyst: GDM; Date Test Completed: 05/20/97.

William L. Lock
Laboratory Director

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Gascoyne Laboratories, Inc.

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army

Sample I.D. Submitted Sludge: APG-J-Field, Sediment ~~Site 13~~ SW-11, Composite, dated 05/07/97

Acid Compounds	Result	Detection Limits
Phenol	<1.5	1.5
2-Chlorophenol	<1.5	1.5
2-Nitrophenol	<1.5	1.5
2,4-Dimethylphenol	<1.5	1.5
2,4-Dichlorophenol	<1.5	1.5
4-Chloro-3-methylphenol	<3.0	3.0
2,4,6-Trichlorophenol	<1.5	1.5
2,4-Dinitrophenol	<7.6	7.6
4-Nitrophenol	<7.6	7.6
4,6-Dinitro-2-methylphenol	<7.6	7.6
Pentachlorophenol	<7.6	7.6
Base/Neutral Compounds		
N-Nitrosodimethylamine	<1.5	1.5
bis(2-Chloroethyl)ether	<1.5	1.5
1,3-Dichlorobenzene	<1.5	1.5
1,4-Dichlorobenzene	<1.5	1.5
1,2-Dichlorobenzene	<1.5	1.5
bis(2-Chloroisopropyl)ether	<1.5	1.5
N-Nitroso-di-n-propylamine	<1.5	1.5
Hexachloroethane	<1.5	1.5
Nitrobenzene	<1.5	1.5
Isophorone	<1.5	1.5
bis(2-Chloroethoxy)methane	<1.5	1.5
1,2,4-Trichlorobenzene	<1.5	1.5
Naphthalene	<1.5	1.5
Hexachlorobutadiene	<1.5	1.5
Hexachlorocyclopentadiene	<1.5	1.5
2-Chloronaphthalene	<1.5	1.5
Dimethyl phthalate	<1.5	1.5
Acenaphthylene	<1.5	1.5

Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Analyses were performed according to EPA Method(s) 8270B.
(3) Analyst: DMJ; Date Test Completed: 05/30/97.

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William L. Lock
Laboratory Director

Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 33 of 36

Sample I.D. Submitted Sludge: APG-J-Field, Sediment ~~Site 13~~ SW-11, Composite, dated 05/07/97

Base/Neutral Compound	Result	Detection Limit
Acenaphthene	<1.5	1.5
2,4-Dinitrotoluene	<1.5	1.5
2,6-Dinitrotoluene	<1.5	1.5
Diethyl phthalate	<1.5	1.5
4-Chlorophenyl phenyl ether	<1.5	1.5
Fluorene	<1.5	1.5
N-Nitrosodiphenylamine (3)	<1.5	1.5
1,2 Diphenylhydrazine (4)	<1.5	1.5
Hexachlorobenzene	<1.5	1.5
Phenanthrene	<1.5	1.5
Anthracene	<1.5	1.5
Di-n-butyl phthalate	4.2	1.5
Fluoranthene	<1.5	1.5
Pyrene	<1.5	1.5
Butyl benzyl phthalate	<1.5	1.5
3,3'Dichlorobenzidine	<3.0	3.0
Benzo(a)anthracene	<1.5	1.5
bis(2-Ethylhexyl)phthalate	<1.5	1.5
Chrysene	<1.5	1.5
Di-n-octyl phthalate	<1.5	1.5
Benzo(b)fluoranthene	<1.5	1.5
Benzo(k)fluoranthene	<1.5	1.5
Benzo(a)pyrene	<1.5	1.5
Indeno(1,2,3-cd)pyrene	<1.5	1.5
Dibenzo(a,h)anthracene	<1.5	1.5
Benzo(ghi)perylene	<1.5	1.5

Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Analyses were performed according to EPA Method 8270.
(3) Cannot be separated from diphenylamine.
(4) Detected as azobenzene.
(5) Analyst: DMJ; Date Test Completed: 05/30/97.

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William L. Lock
Laboratory Director

Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 34 of 36

Sample I.D. Submitted Sludge: APG-J-Field, Sediment ~~Site 13~~ SW-11, Composite, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date Test Completed
Aluminum (Al)	14000	20	EPA 6010A	PDB	05/22/97
Antimony (Sb)	<120	120	EPA 6010A	PDB	05/22/97
Arsenic (As)	<120	120	EPA 6010A	PDB	05/22/97
Beryllium (Be)	<1	1	EPA 6010A	PDB	05/22/97
Boron (B)	26	10	EPA 6010A	PDB	05/22/97
Cadmium (Cd)	5	2	EPA 6010A	PDB	05/22/97
Calcium (Ca)	5000	120	EPA 6010A	PDB	05/22/97
Chromium (Cr)	99	5	EPA 6010A	PDB	05/22/97
Cobalt (Co)	<2	2	EPA 6010A	PDB	05/22/97
Copper (Cu)	590	2	EPA 6010A	PDB	05/22/97
Hardness (CaCO3)	36000	400	EPA 6010A	PDB	05/22/97
Iron (Fe)	34000	20	EPA 6010A	PDB	05/22/97
Lead (Pb)	2500	20	EPA 6010A	PDB	05/22/97
Magnesium (Mg)	5700	20	EPA 6010A	PDB	05/22/97
Manganese (Mn)	140	2	EPA 6010A	PDB	05/22/97
Mercury (Hg)	1.5	0.2	EPA 7470A	MMM	05/22/97
Molybdenum (Mo)	<5	5	EPA 6010A	PDB	05/22/96
Nickel (Ni)	29	5	EPA 6010A	PDB	05/22/96
Potassium (K)	1100	20	EPA 6010A	PDB	05/22/96
Selenium (Se)	<0.2	0.2	EPA 7740	CJK	05/23/97
Silver (Ag)	5	5	EPA 6010A	PDB	05/22/97
Sodium (Na)	490	120	EPA 6010A	PDB	05/22/97
Thallium (Tl)	<120	120	EPA 6010A	PDB	05/22/97
Tin (Sn)	<50	50	EPA 6010A	PDB	05/22/97
Zinc (Zn)	2200	5	EPA 6010A	PDB	05/22/97

Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.

William L. Lock
Laboratory Director

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YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 35 of 36

Sample I.D. Submitted Sludge: APG-J-Field, Sediment ~~Site 13~~ SW-11, Composite, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date T Comple
Alkalinity (CaCO3)	220	50	EPA 310.1-M	DMW	06/05
Ammonia (N)	260	82	SM4500-NH3 E	RED	05/23
Bromide	<1.0	1.0	EPA 9056	PBK	05/08
Chloride (Cl)	450	23	CA 422	PRG	05/13
Cyanide (CN), Extractable	<1	1	EPA 335.3-M	RED	05/11
Fluoride (F), Undistilled	3.7	1.0	EPA 9056	PBK	05/08
Nitrate (N)	2.0	0.2	EPA 9056	PBK	05/08
Nitrite (N)	<0.20	0.20	EPA 9056	PBK	05/08
pH (2)	6.6	NA	EPA 9045-C	PRG	05/12
Phosphorus (P), Total (2)	0.19	0.01	SM4500-P C	PRG	05/09
Specific Conductance (4)	0.625	NA	CA 643	PRG	05/13
Sulfate (SO4)	33	23	CA 417	PRG	05/13
Sulfide (S)	270	23	EPA 9030 A	PRG	05/23
Total Organic Carbon (2)	9.4	0.5	Walkley-Black	PRG	05/23
Total Solids (3)	21.5	0.1	ASTM D2216	WS	05/09

Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Results expressed as weight percent (%) on a dry weight basis
(3) Results expressed as percent (%) on a as received basis.
(4) Results expressed as mmhos/cm.

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William L. Lock
Laboratory Director

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WED 5/21/97
INITIALS DATE

Department of the Army
U.S. Army Biomedical Research and Development Laboratory
Research Methods Branch

ANALYTICAL CHEMISTRY REPORT

TEST NUMBER NA DATE REPORTED 5/21/97

ANALYSIS/MATRIX MUNITIONS / SOIL

Collection Site	Date(s) Collected	Date(s) Analyzed
BRDL RM 7	5/15/97	5/15-5/22/97

Chemistry Accession Number	Sample Identification (SW-11)	Concentration - mg/L				
		Replicate 1	Replicate 2	Replicate 3	Mean	Std. Dev.
	J-Field ~~Site 13~~ A					
	Sediment					
97-1555	97-134-2					
	HMX	BDL	BDL	BDL	BDL	
	RDX	BDL	BDL	BDL	BDL	
	TNB	BDL	BDL	BDL	BDL	
	1,3-DNB	BDL	BDL	BDL	BDL	
	TETRYL	BDL	BDL	BDL	BDL	
	NB	BDL	BDL	BDL	BDL	
	TNT	BDL	BDL	BDL	BDL	
	4-AM-2,6-DNT	BDL	BDL	BDL	BDL	
	2-AM-4,6-DNT	BDL	BDL	BDL	BDL	
	2,6-DNT	BDL	BDL	BDL	BDL	
	2,4-DNT	BDL	BDL	BDL	BDL	
	2-NT	BDL	BDL	BDL	BDL	
	4-NT	BDL	BDL	BDL	BDL	
	3-NT	BDL	BDL	BDL	BDL	
			dry weight			

The Detectable limit for this method is 0.5 ug/g of soil

Comments:
An interfering peak with a similar retenition time to TNB was found. It was verified not to be TNB by altering the composition of the mobile phase.

Chemist _____ Date 5/21/97

Reviewed by _____ Date _____

Form No. 46-4

APPENDIX 21

COMPREHENSIVE CHEMICAL AND MUNITIONS ANALYSES CONDUCTED ON SURFACE WATER FROM J-FIELD SW-12 (HIGH AQUIFER FLOW)

Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 22 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 14~~ SW-12, Grab, dated 05/07/97

Compound	Results	Detection Limits
Chloromethane	<10	10
Bromomethane	<10	10
Vinyl chloride	<10	10
Chloroethane	<10	10
Methylene chloride	<5	5
Acrolein	<100	100
Acrylonitrile	<100	100
Trichlorofluoromethane	<5	5
1,1-Dichloroethane	<5	5
trans-1,2-Dichloroethene	<5	5
Chloroform	<5	5
1,2-Dichloroethane	<5	5
1,1,1-Trichloroethane	<5	5
Carbon tetrachloride	<5	5
Bromodichloromethane	<5	5
1,2-Dichloropropane	<5	5
cis-1,3-Dichloropropene	<5	5
trans-1,3-Dichloropropene	<5	5
1,3-Dichloropropene	<5	5
Dibromochloromethane	<5	5
1,1,2-Trichloroethane	<5	5
2-Chloroethylvinyl ether	<10	10
Bromoform	<5	5
Tetrachloroethene	<5	5
1,1,2,2-Tetrachloroethane	<5	5
Ethylbenzene	<5	5
1,1-Dichloroethene	<5	5
Trichloroethene	<5	5
Benzene	<5	5
Toluene	<5	5
Chlorobenzene	<5	5
Total Xylenes	<10	10

Notes: (1) Results expressed as ug/l (ppb).
(2) Analysis performed according to method EPA 8260A.
(3) Analyst(s): TLN; Date Test Completed: 05/09/97.

William L. Lock
Laboratory Director

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Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 23 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 14~~ SW-12, Grab, dated 05/07/97

Pesticides/PCB's	Result	Detection Limit
a-BHC	<0.05	0.05
b-BHC	<0.05	0.05
g-BHC	<0.05	0.05
d-BHC	<0.05	0.05
Heptachlor	<0.05	0.05
Aldrin	<0.05	0.05
Heptachlor epoxide	<0.05	0.05
A-Endosulfan	<0.1	0.1
4,4'-DDE	<0.1	0.1
Dieldrin	<0.1	0.1
Endrin	<0.1	0.1
B-Endosulfan	<0.3	0.3
Endrin aldehyde	<0.3	0.3
4,4'-DDD	<0.3	0.3
Endosulfan sulfate	<0.3	0.3
4,4'-DDT	<0.3	0.3
PCB-1242	<1	1
PCB-1254	<1	1
PCB-1221	<1	1
PCB-1232	<1	1
PCB-1248	<1	1
PCB-1260	<1	1
PCB-1016	<1	1
Chlordane	<1	1
Toxaphene	<3	3

Notes: (1) Results expressed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method 3510B/ 8080A.
(3) Analyst: GDM; Date Test Completed: 05/14/97.

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ABR 6/25/97
INITIALS DATE

William L. Lock
Laboratory Director

Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army

Sample I.D. Submitted Water: APG-J-Field, ~~Site 14~~ SW-12, Grab, dated 05/07/97

Herbicides	Result	Detection Limit
2,4-D	<0.5	0.5
2,4,5-TP (Silvex)	<0.2	0.2

Notes: (1) Results expresssed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method 8150B.
(3) Analyst: GDM; Date Test Completed: 05/13/97.

William L. Lock
Laboratory Director

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army

Sample I.D. Submitted Water: APG-J-Field, ~~Site 14~~ SW-12, Grab, dated 05/07/97

Acid Compounds	Result	Detection Limits
Phenol	<10	10
2-Chlorophenol	<10	10
2-Nitrophenol	<10	10
2,4-Dimethylphenol	<10	10
2,4-Dichlorophenol	<10	10
4-Chloro-3-methylphenol	<20	20
2,4,6-Trichlorophenol	<10	10
2,4-Dinitrophenol	<50	50
4-Nitrophenol	<50	50
4,6-Dinitro-2-methylphenol	<50	50
Pentachlorophenol	<50	50
Base/Neutral Compounds		
N-Nitrosodimethylamine	<10	10
bis(2-Chloroethyl)ether	<10	10
1,3-Dichlorobenzene	<10	10
1,4-Dichlorobenzene	<10	10
1,2-Dichlorobenzene	<10	10
bis(2-Chloroisopropyl)ether	<10	10
N-Nitroso-di-n-propylamine	<10	10
Hexachloroethane	<10	10
Nitrobenzene	<10	10
Isophorone	<10	10
bis(2-Chloroethoxy)methane	<10	10
1,2,4-Trichlorobenzene	<10	10
Naphthalene	<10	10
Hexachlorobutadiene	<10	10
Hexachlorocyclopentadiene	<10	10
2-Chloronaphthalene	<10	10
Dimethyl phthalate	<10	10
Acenaphthylene	<10	10

Notes: (1) Results expressed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method(s) 8270B.
(3) Analyst: DMJ; Date Test Completed: 05/28/97.

William A. Lock
Laboratory Director

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 26 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 14~~ SW-12, Grab, dated 05/07/97

Base/Neutral Compound	Result	Detection Limit
Acenaphthene	<10	10
2,4-Dinitrotoluene	<10	10
2,6-Dinitrotoluene	<10	10
Diethyl phthalate	<10	10
4-Chlorophenyl phenyl ether	<10	10
Fluorene	<10	10
N-Nitrosodiphenylamine (3)	<10	10
1,2 Diphenylhydrazine (4)	<10	10
Hexachlorobenzene	<10	10
Phenanthrene	<10	10
Anthracene	<10	10
Di-n-butyl phthalate	<10	10
Fluoranthene	<10	10
Pyrene	<10	10
Butyl benzyl phthalate	<10	10
3,3'Dichlorobenzidine	<20	20
Benzo(a)anthracene	<10	10
bis(2-Ethylhexyl)phthalate	<10	10
Chrysene	<10	10
Di-n-octyl phthalate	<10	10
Benzo(b)fluoranthene	<10	10
Benzo(k)fluoranthene	<10	10
Benzo(a)pyrene	<10	10
Indeno(1,2,3-cd)pyrene	<10	10
Dibenzo(a,h)anthracene	<10	10
Benzo(ghi)perylene	<10	10

Notes: (1) Results expressed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method 8270.
(3) Cannot be separated from diphenylamine.
(4) Detected as azobenzene.
(5) Analyst: DMJ; Date Test Completed: 05/28/97

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Laboratory Director

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 27 of 36

Sample I.D. Submitted Water: APG-J-Field, ~~Site 14~~ SW-12, Grab, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date Tes Complete
Aluminum (Al)	0.4	0.1	EPA 6010A	PDB	05/22/9
Antimony (Sb)	<0.5	0.5	EPA 6010A	PDB	05/22/9
Arsenic (As)	<0.5	0.5	EPA 6010A	PDB	05/22/9
Beryllium (Be)	<0.005	0.005	EPA 6010A	PDB	05/22/9
Boron (B)	0.19	0.05	EPA 6010A	PDB	05/22/9
Cadmium (Cd)	<0.01	0.01	EPA 6010A	PDB	05/22/9
Calcium (Ca)	34	0.5	EPA 6010A	PDB	05/22/9
Chromium (Cr)	<0.02	0.02	EPA 6010A	PDB	05/22/9
Cobalt (Co)	<0.01	0.01	EPA 6010A	PDB	05/22/9
Copper (Cu)	0.05	0.01	EPA 6010A	PDB	05/22/9
Hardness (CaCO3)	290	2	EPA 6010A	PDB	05/22/9
Iron (Fe)	15	0.1	EPA 6010A	PDB	05/22/9
Lead (Pb)	0.2	0.1	EPA 6010A	PDB	05/22/9
Magnesium (Mg)	51	0.1	EPA 6010A	PDB	05/22/9
Manganese (Mn)	0.31	0.01	EPA 6010A	PDB	05/22/9
Mercury (Hg)	<0.0002	0.0002	EPA 7470A	MMM	05/22/9
Molybdenum (Mo)	<0.02	0.02	EPA 6010A	PDB	05/22/9
Nickel (Ni)	<0.02	0.02	EPA 6010A	PDB	05/22/9
Potassium (K)	7.0	0.1	EPA 6010A	PDB	05/22/9
Selenium (Se)	<0.005	0.005	EPA 7740	CJK	05/23/9
Silver (Ag)	<0.02	0.02	EPA 6010A	PDB	05/22/9
Sodium (Na)	58	0.5	EPA 6010A	PDB	05/22/9
Thallium (Tl)	<0.5	0.5	EPA 6010A	PDB	05/22/9
Tin (Sn)	<0.2	0.2	EPA 6010A	PDB	05/22/9
Zinc (Zn)	0.63	0.02	EPA 6010A	PDB	05/22/9

Notes: (1) Results expressed as mg/l (ppm).

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Laboratory Director

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Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826-R

Report Date: June 18, 1997

Report To: U.S. Army

Sample I.D. Submitted Water: APG-J-Field, ~~Site 14~~ SW-12, Grab, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date Test Completed
Alkalinity (CaCO3)	240	4	EPA 310.1	RED	05/24/97
Ammonia (N)	<1	1	SM4500-NH3 E	RED	05/28/97
Bromide	0.51	0.05	EPA 9056	PBK	05/08/97
Chloride (Cl)	130	1.0	EPA 9056	PBK	05/16/97
Cyanide (CN), Total	<0.01	0.01	EPA 335.3	RED	05/11/97
Fluoride (F), Undistilled	0.27	0.05	EPA 9056	RED	05/24/97
Nitrate (N)	<0.01	0.01	EPA 9056	PBK	05/08/97
Nitrite (N)	<0.01	0.01	EPA 9056	PBK	05/08/97
pH (2)	7.5	NA	EPA 9040B	TMV	05/07/97
Phosphorus (P), Total	0.26	0.01	SM4500-P E	DMW	05/16/97
Specific Conductance (3)	820	NA	EPA 9050	DMW	05/23/97
Sulfate (SO4)	6	1	EPA 9056	PBK	05/08/97
Sulfide (S), Dissolved	<1	1	EPA 376.1	DMW	05/12/97
Total Organic Carbon	15	1	EPA 9060	RED	05/16/97
Total Suspended Solids	66	5	EPA 160.2	LAT	05/09/97

Notes: (1) Results expressed as mg/l (ppm).
(2) Results expressed as pH units.
(3) Results expressed as micromhos/cm.
(4) Report revised to correct typographical error in detection limit for alkalinity.

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Laboratory Director

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Department of the Army
U.S. Army Biomedical Research and Development Laboratory
Research Methods Branch

ANALYTICAL CHEMISTRY REPORT

TEST NUMBER NA DATE REPORTED 5/20/97

ANALYSIS/MATRIX MUNITIONS / WATER

Collection Site: BRDL RM 7 | Date(s) Collected: 5/15/97 | Date(s) Analyzed: 5/15-5/19/97

Chemistry Accession Number	Sample Identification (SW-12)	Concentration - mg/L				
		Replicate 1	Replicate 2	Replicate 3	Mean	Std. Dev.
	J-Field ~~site 14~~ A					
	Surface Water					
97-1558	97-134-5					
	HMX	BDL	BDL	BDL	BDL	
	RDX	BDL	BDL	BDL	BDL	
	TNB	BDL	BDL	BDL	BDL	
	1,3-DNB	BDL	BDL	BDL	BDL	
	TETRYL	BDL	BDL	BDL	BDL	
	NB	BDL	BDL	BDL	BDL	
	TNT	BDL	BDL	BDL	BDL	
	4-AM-2,6-DNT	BDL	BDL	BDL	BDL	
	2-AM-4,6-DNT	BDL	BDL	BDL	BDL	
	2,6-DNT	BDL	BDL	BDL	BDL	
	2,4-DNT	BDL	BDL	BDL	BDL	
	2-NT	BDL	BDL	BDL	BDL	
	4-NT	BDL	BDL	BDL	BDL	
	3-NT	BDL	BDL	BDL	BDL	

The Detectable limit for this method is 50 ug/L

Comments:

Chemist _____ Date 5/20/97

Reviewed by _____ Date _____

Form No. 46-4

APPENDIX 22

COMPREHENSIVE CHEMICAL AND MUNITIONS ANALYSES CONDUCTED ON GROUNDWATER FROM J-FIELD WELL JF8-3 (HIGH AQUIFER FLOW)

JUN 26

Gascoyne Laboratories, Inc.

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Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826-A

Report Date: June 23, 1997

Report To: U.S. Army

Page: 1 of 2 36

R.E. ABR 6/25/97

Sample I.D. Submitted Water: APG-J-Field, JF8-3, Grab, dated 05/07/97

Compound	Results	Detection Limits
Chloromethane	<10	10
Bromomethane	<10	10
Vinyl chloride	13	10
Chloroethane	<10	10
Methylene chloride	<5	5
Acrolein	<100	100
Acrylonitrile	<100	100
Trichlorofluoromethane	<5	5
1,1-Dichloroethane	<5	5
trans-1,2-Dichloroethene (4)	1800	5
Chloroform	36	5
1,2-Dichloroethane	<5	5
1,1,1-Trichloroethane	<5	5
Carbon tetrachloride	5	5
Bromodichloromethane	<5	5
1,2-Dichloropropane	<5	5
cis-1,3-Dichloropropene	<5	5
trans-1,3-Dichloropropene	<5	5
1,3-Dichloropropene	<5	5
Dibromochloromethane	<5	5
1,1,2-Trichloroethane (4)	1700	5
2-Chloroethylvinyl ether	<10	10
Bromoform	<5	5
Tetrachloroethene (4)	2300	5
1,1,2,2-Tetrachloroethane (4)	130000	5
Ethylbenzene	<5	5
1,1-Dichloroethene	10	10
Trichloroethene (4)	32000	5
Benzene	5	5
Toluene	<5	5
Chlorobenzene	<5	5
Total Xylenes	<10	10

Notes:
(1) Results expressed as ug/l (ppb).
(2) Analysis performed according to method EPA 8260A.
(3) Analyst(s): TLN; Date Test Completed: 05/08/97.
(4) Reported results estimated; results outside of linear calibration range.
(5) Reported results for test completed on 05/08/97 estimated due to surrogate recovery outside acceptable limits.

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army

Sample I.D. Submitted Water: APG-J-Field, JF8-3, Grab, dated 05/07/97

Pesticides/PCB's	Result	Detection Limit
a-BHC	<0.05	0.05
b-BHC	<0.05	0.05
g-BHC	<0.05	0.05
d-BHC	<0.05	0.05
Heptachlor	<0.05	0.05
Aldrin	<0.05	0.05
Heptachlor epoxide	<0.05	0.05
A-Endosulfan	<0.1	0.1
4,4'-DDE	<0.1	0.1
Dieldrin	<0.1	0.1
Endrin	<0.1	0.1
B-Endosulfan	<0.3	0.3
Endrin aldehyde	<0.3	0.3
4,4'-DDD	<0.3	0.3
Endosulfan sulfate	<0.3	0.3
4,4'-DDT	<0.3	0.3
PCB-1242	<1	1
PCB-1254	<1	1
PCB-1221	<1	1
PCB-1232	<1	1
PCB-1248	<1	1
PCB-1260	<1	1
PCB-1016	<1	1
Chlordane	<1	1
Toxaphene	<3	3

Notes: (1) Results expressed as ug/liter(ppb).
(2) Analyses were performed according to EPA Method 3510B/ 8080A.
(3) Analyst: GDM; Date Test Completed: 05/14/97.

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 3 of 36

Sample I.D. Submitted Water: APG-J-Field, JF8-3, Grab, dated 05/07/97

Herbicides	Result	Detection Limit
2,4-D	<0.5	0.5
2,4,5-TP (Silvex)	<0.2	0.2

Notes: (1) Results expresssed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method 8150B.
(3) Analyst: GDM; Date Test Completed: 05/13/97.

William L. Lock
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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army

Sample I.D. Submitted Water: APG-J-Field, JF8-3, Grab, dated 05/07/97

Acid Compounds	Result	Detection Limits
Phenol	<10	10
2-Chlorophenol	<10	10
2-Nitrophenol	<10	10
2,4-Dimethylphenol	<10	10
2,4-Dichlorophenol	<10	10
4-Chloro-3-methylphenol	<20	20
2,4,6-Trichlorophenol	<10	10
2,4-Dinitrophenol	<50	50
4-Nitrophenol (4)	<50	50
4,6-Dinitro-2-methylphenol	<50	50
Pentachlorophenol (5)	<50	50
Base/Neutral Compounds		
N-Nitrosodimethylamine	<10	10
bis(2-Chloroethyl)ether	<10	10
1,3-Dichlorobenzene	<10	10
1,4-Dichlorobenzene	<10	10
1,2-Dichlorobenzene	<10	10
bis(2-Chloroisopropyl)ether	<10	10
N-Nitroso-di-n-propylamine	<10	10
Hexachloroethane	97	10
Nitrobenzene	<10	10
Isophorone	<10	10
bis(2-Chloroethoxy)methane	<10	10
1,2,4-Trichlorobenzene	<10	10
Naphthalene	<10	10
Hexachlorobutadiene	<10	10
Hexachlorocyclopentadiene	<10	10
2-Chloronaphthalene	<10	10
Dimethyl phthalate	<10	10
Acenaphthylene	<10	10

Notes: (1) Results expressed as ug/liter (ppb).
(2) Analyses were performed according to EPA Method(s) 8270B.
(3) Analyst: DMJ; Date Test Completed: 05/28/97
(4) Reported result estimated due to matrix spike duplicate recovery outside of acceptable limits.
(5) Reported result estimated due to matrix spike and matrix spike duplicate recovery outside of acceptable limits.

William L. Lock
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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 5 of 36

Sample I.D. Submitted Water: APG-J-Field, JF8-3, Grab, dated 05/07/97

Base/Neutral Compound	Result	Detection Limit
Acenaphthene	<10	10
2,4-Dinitrotoluene (6)	<10	10
2,6-Dinitrotoluene	<10	10
Diethyl phthalate	<10	10
4-Chlorophenyl phenyl ether	<10	10
Fluorene	<10	10
N-Nitrosodiphenylamine (3)	<10	10
1,2 Diphenylhydrazine (4)	<10	10
Hexachlorobenzene	<10	10
Phenanthrene	<10	10
Anthracene	<10	10
Di-n-butyl phthalate	<10	10
Fluoranthene	<10	10
Pyrene	<10	10
Butyl benzyl phthalate	<10	10
3,3'Dichlorobenzidine	<20	20
Benzo(a)anthracene	<10	10
bis(2-Ethylhexyl)phthalate	<10	10
Chrysene	<10	10
Di-n-octyl phthalate	<10	10
Benzo(b)fluoranthene	<10	10
Benzo(k)fluoranthene	<10	10
Benzo(a)pyrene	<10	10
Indeno(1,2,3-cd)pyrene	<10	10
Dibenzo(a,h)anthracene	<10	10
Benzo(ghi)perylene	<10	10

Notes:
(1) Results expressed as ug/l (ppb).
(2) Analyses were performed according to EPA Method 8270B.
(3) Cannot be separated from diphenylamine.
(4) Detected as azobenzene.
(5) Analyst: DMJ; Date Test Completed: 05/28/97.
(6) Reported result estimated due to matrix spike duplicate recovery outside of acceptable limits.

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REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army

Sample I.D. Submitted Water: APG-J-Field, JF8-3, Grab, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date Test Completed
Aluminum (Al)	<0.1	0.1	EPA 6010A	PDB	05/22/97
Antimony (Sb)	<0.5	0.5	EPA 6010A	PDB	05/22/97
Arsenic (As)	<0.5	0.5	EPA 6010A	PDB	05/22/97
Beryllium (Be)	<0.005	0.005	EPA 6010A	PDB	05/22/97
Boron (B)	0.26	0.05	EPA 6010A	PDB	05/22/97
Cadmium (Cd)	<0.01	0.01	EPA 6010A	PDB	05/22/97
Calcium (Ca)	44	0.5	EPA 6010A	PDB	05/22/97
Chromium (Cr)	<0.02	0.02	EPA 6010A	PDB	05/22/97
Cobalt (Co)	<0.01	0.01	EPA 6010A	PDB	05/22/97
Copper (Cu)	<0.01	0.01	EPA 6010A	PDB	05/22/97
Hardness (CaCO3)	190	2	EPA 6010A	PDB	05/22/97
Iron (Fe)	0.1	0.1	EPA 6010A	PDB	05/22/97
Lead (Pb)	<0.1	0.1	EPA 6010A	PDB	05/22/97
Magnesium (Mg)	20	0.1	EPA 6010A	PDB	05/22/97
Manganese (Mn)	0.10	0.01	EPA 6010A	PDB	05/22/97
Mercury (Hg)	<0.0002	0.0002	EPA 7470A	MMM	05/22/97
Molybdenum (Mo)	<0.02	0.02	EPA 6010A	PDB	05/22/96
Nickel (Ni)	<0.02	0.02	EPA 6010A	PDB	05/22/96
Potassium (K)	0.3	0.1	EPA 6010A	PDB	05/22/96
Selenium (Se)	<0.005	0.005	EPA 7740	CJK	05/23/97
Silver (Ag)	<0.02	0.02	EPA 6010A	PDB	05/22/97
Sodium (Na)	18	0.5	EPA 6010A	PDB	05/22/97
Thallium (Tl)	<0.5	0.5	EPA 6010A	PDB	05/22/97
Tin (Sn)	<0.2	0.2	EPA 6010A	PDB	05/22/97
Zinc (Zn)	<0.02	0.02	EPA 6010A	PDB	05/22/97

Notes: (1) Results expressed as mg/l (ppm).

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Laboratory Director

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Baltimore, MD 21224

REPORT OF ANALYSIS

Report No. 9700826 Report Date: June 4, 1997

Report To: U.S. Army Page: 7 of 36

Sample I.D. Submitted Water: APG-J-Field, JF8-3, Grab, dated 05/07/97

	Test Results	Detection Limits	Method	Analyst	Date Te Comple
Alkalinity (CaCO3)	82	1	EPA 310.1	DMW	05/13,
Ammonia (N)	<1	1	SM4500-NH3 E	RED	05/28,
Bromide	0.06	0.05	EPA 9056	PBK	05/08,
Chloride (Cl)	86	0.4	EPA 9056	PBK	05/16,
Cyanide (CN), Total	<0.01	0.01	EPA 335.3	RED	05/11,
Fluoride (F), Undistilled	<0.25	0.25	EPA 9056	RED	05/24,
Nitrate (N)	3.9	0.01	EPA 9056	PBK	05/08,
Nitrite (N)	<0.01	0.01	EPA 9056	PBK	05/08,
pH (2)	6.2	NA	EPA 9040B	TMV	05/07,
Phosphorus (P), Total	0.23	0.01	SM4500-P E	DMW	05/16,
Specific Conductance (3)	480	NA	EPA 9050	DMW	05/23,
Sulfate (SO4)	45	0.2	EPA 9056	PBK	05/08,
Sulfide (S), Total	<1	1	EPA 376.1	DMW	05/12,
Total Organic Carbon	2	1	EPA 9060	RED	05/16,
Total Suspended Solids	2	1	EPA 160.2	LAT	05/09,

Notes: (1) Results expressed as mg/l (ppm).
(2) Results expressed as pH units.
(3) Results expressed as micromhos/cm.

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Department of the Army
U.S. Army Biomedical Research and Development Laboratory
Research Methods Branch

ANALYTICAL CHEMISTRY REPORT

TEST NUMBER NA DATE REPORTED 5/20/97

ANALYSIS/MATRIX MUNITIONS / WATER

Collection Site	Date(s) Collected	Date(s) Analyzed
BRDL RM 7	5/15/97	5/15-5/19/97

Chemistry Accession Number	Sample Identification	Concentration - mg/L				
		Replicate 1	Replicate 2	Replicate 3	Mean	Std. Dev.
	J-Field Well					
	JF8-3					
97-1559	97-134-6					
	HMX	BDL	BDL	BDL	BDL	
	RDX	BDL	BDL	BDL	BDL	
	TNB	BDL	BDL	BDL	BDL	
	1,3-DNB	BDL	BDL	BDL	BDL	
	TETRYL	BDL	BDL	BDL	BDL	
	NB	BDL	BDL	BDL	BDL	
	TNT	BDL	BDL	BDL	BDL	
	4-AM-2,6-DNT	BDL	BDL	BDL	BDL	
	2-AM-4,6-DNT	BDL	BDL	BDL	BDL	
	2,6-DNT	BDL	BDL	BDL	BDL	
	2,4-DNT	BDL	BDL	BDL	BDL	
	2-NT	BDL	BDL	BDL	BDL	
	4-NT	BDL	BDL	BDL	BDL	
	3-NT	BDL	BDL	BDL	BDL	

The Detectable limit for this method is 50 ug/L

Comments:

Chemist _____ Date 5/20/97

Reviewed by _____ Date _____

Form No. 46-4

APPENDIX 23

COMPREHENSIVE CHEMICAL AND MUNITIONS ANALYSES CONDUCTED ON SURFICIAL SEDIMENT FROM J-FIELD SOUTH BEACH (HIGH AQUIFER FLOW)

JUN 26 1997

Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

Baltimore, MD 21224

(410) 633-1800
(800) GAS-COYN
FAX NO
(410) 633-5443

REPORT OF ANALYSIS

Report No. 9701000 Report Date: June 09, 1997

Report To: U.S. Army Page: 1 of 8

Sample I.D. Submitted Sludge: APG-J-Field, Sediment Ches. Bay (South Bench) Composite, dated 05/14/97

DTB 6-26-97

Compound	Results	Detection Limits
Chloromethane	<1.7	1.7
Bromomethane	<1.7	1.7
Vinyl chloride	<1.7	1.7
Chloroethane	<1.7	1.7
Methylene chloride	<0.86	0.86
Acrolein	<17	17
Acrylonitrile	<17	17
Trichlorofluoromethane	<0.86	0.86
1,1-Dichloroethane	<0.86	0.86
trans-1,2-Dichloroethene	<0.86	0.86
Chloroform	<0.86	0.86
1,2-Dichloroethane	<0.86	0.86
1,1,1-Trichloroethane	<0.86	0.86
Carbon tetrachloride	<0.86	0.86
Bromodichloromethane	<0.86	0.86
1,2-Dichloropropane	<0.86	0.86
cis-1,3-Dichloropropene	<1.7	1.7
trans-1,3-Dichloropropene	<0.86	0.86
1,3-Dichloropropene	<0.86	0.86
Dibromochloromethane	<0.86	0.86
1,1,2-Trichloroethane	<0.86	0.86
2-Chloroethylvinyl ether	<0.86	0.86
Bromoform	<0.86	0.86
Tetrachloroethene	<0.86	0.86
1,1,2,2-Tetrachloroethane	<0.86	0.86
Ethylbenzene	<0.86	0.86
1,1-Dichloroethene	<0.86	0.86
Trichloroethene	<0.86	0.86
Benzene	<0.86	0.86
Toluene	<0.86	0.86
Chlorobenzene	<0.86	0.86
Total Xylenes	<1.73	1.73

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AGR 6/25/97
INITIALS DATE

Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Analysis performed according to method EPA 8260A.
(3) Analyst(s): SJN; Date Test Completed: 05/27/97.

William L. Lock
Laboratory Director

Gascoyne Laboratories, Inc.

YOUR **ON-TIME** QUALITY LAB...

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REPORT OF ANALYSIS

Report No. 9701000 Report Date: June 09, 1997

Report To: U.S. Army

Sample I.D. Submitted Sludge: APG-J-Field, Sediment Ches. Bay, (South Be
Composite, dated 05/14/97

Pesticides/PCB's	Result	Detection Limit
a-BHC	<0.09	0.09
b-BHC	<0.09	0.09
g-BHC	<0.09	0.09
d-BHC	<0.09	0.09
Heptachlor	<0.09	0.09
Aldrin	<0.09	0.09
Heptachlor epoxide	<0.09	0.09
A-Endosulfan	<0.2	0.2
4,4'-DDE	<0.2	0.2
Dieldrin	<0.2	0.2
Endrin	<0.2	0.2
B-Endosulfan	<0.5	0.5
Endrin aldehyde	<0.5	0.5
4,4'-DDD	<0.5	0.5
Endosulfan sulfate	<0.5	0.5
4,4'-DDT	<0.5	0.5
PCB-1242	<2	2
PCB-1254	<2	2
PCB-1221	<2	2
PCB-1232	<2	2
PCB-1248	<2	2
PCB-1260	<2	2
PCB-1016	<2	2
Chlordane	<2	2
Toxaphene	<5	5

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INITIALS DATE

Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Analyses were performed according to EPA Method 3550A/ 8081.
(3) Analyst: GDM; Date Test Completed: 05/23/97.

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REPORT OF ANALYSIS

Report No. 9701000 Report Date: June 09, 1997

Report To: U.S. Army Page: 3 of 8

Sample I.D. Submitted Sludge: APG-J-Field, Sediment Ches. Bay, (South Beach) Composite, dated 05/14/97

Herbicides	Result	Detection Limit
2,4-D	<0.09	0.09
2,4,5-TP (Silvex)	<0.03	0.03

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INITIALS DATE

Notes: (1) Results expresssed as mg/kg (ppm) on a dry weight basis.
(2) Analyses were performed according to EPA Method 8151.
(3) Analyst: GDM; Date Test Completed: 05/30/97.

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REPORT OF ANALYSIS

Report No. 9701000 Report Date: June 09, 1997

Report To: U.S. Army Page: 4 of 8

Sample I.D. Submitted Sludge: APG-J-Field, Sediment Ches. Bay, (South Be
Composite, dated 05/14/97

Acid Compounds	Result	Detection Limits
Phenol	<0.58	0.58
2-Chlorophenol	<0.58	0.58
2-Nitrophenol	<0.58	0.58
2,4-Dimethylphenol	<0.58	0.58
2,4-Dichlorophenol	<0.58	0.58
4-Chloro-3-methylphenol	<1.2	1.2
2,4,6-Trichlorophenol	<0.58	0.58
2,4-Dinitrophenol	<2.9	2.9
4-Nitrophenol	<2.9	2.9
4,6-Dinitro-2-methylphenol	<2.9	2.9
Pentachlorophenol	<2.9	2.9
Base/Neutral Compounds		
N-Nitrosodimethylamine	<0.58	0.58
bis(2-Chloroethyl)ether	<0.58	0.58
1,3-Dichlorobenzene	<0.58	0.58
1,4-Dichlorobenzene	<0.58	0.58
1,2-Dichlorobenzene	<0.58	0.58
bis(2-Chloroisopropyl)ether	<0.58	0.58
N-Nitroso-di-n-propylamine	<0.58	0.58
Hexachloroethane	<0.58	0.58
Nitrobenzene	<0.58	0.58
Isophorone	<0.58	0.58
bis(2-Chloroethoxy)methane	<0.58	0.58
1,2,4-Trichlorobenzene	<0.58	0.58
Naphthalene	<0.58	0.58
Hexachlorobutadiene	<0.58	0.58
Hexachlorocyclopentadiene	<0.58	0.58
2-Chloronaphthalene	<0.58	0.58
Dimethyl phthalate	<0.58	0.58
Acenaphthylene	<0.58	0.58

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Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Analyses were performed according to EPA Method(s) 8270B.
(3) Analyst: DMJ; Date Test Completed: 06/02/97.

William L. Lock
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YOUR **ON-TIME** QUALITY LAB...

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REPORT OF ANALYSIS

Report No. 9701000 Report Date: June 4, 1997

Report To: U.S. Army Page: 5 of 8

Sample I.D. Submitted Sludge: APG-J-Field, Sediment Ches. Bay, (South Beach) Composite, dated 05/14/97

Base/Neutral Compound	Result	Detection Limit
Acenaphthene	<0.58	0.58
2,4-Dinitrotoluene	<0.58	0.58
2,6-Dinitrotoluene	<0.58	0.58
Diethyl phthalate	<0.58	0.58
4-Chlorophenyl phenyl ether	<0.58	0.58
Fluorene	<0.58	0.58
N-Nitrosodiphenylamine (3)	<0.58	0.58
1,2 Diphenylhydrazine (4)	<0.58	0.58
Hexachlorobenzene	<0.58	0.58
Phenanthrene	<0.58	0.58
Anthracene	<0.58	0.58
Di-n-butyl phthalate	3100	0.58
Fluoranthene	<0.58	0.58
Pyrene	<0.58	0.58
Butyl benzyl phthalate	<0.58	0.58
3,3'Dichlorobenzidine	<1.2	1.2
Benzo(a)anthracene	<0.58	0.58
bis(2-Ethylhexyl)phthalate	<0.58	0.58
Chrysene	<0.58	0.58
Di-n-octyl phthalate	<0.58	0.58
Benzo(b)fluoranthene	<0.58	0.58
Benzo(k)fluoranthene	<0.58	0.58
Benzo(a)pyrene	<0.58	0.58
Indeno(1,2,3-cd)pyrene	<0.58	0.58
Dibenzo(a,h)anthracene	<0.58	0.58
Benzo(ghi)perylene	<0.58	0.58

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Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Analyses were performed according to EPA Method 8270B.
(3) Cannot be separated from diphenylamine.
(4) Detected as azobenzene.
(5) Analyst: DMJ; Date Test Completed: 06/02/97.

William L. Lock
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REPORT OF ANALYSIS

Report No. 9701000

Report Date: June 09, 1997

Report To: U.S. Army

Page: 6 of 8
(South Beach)

Sample I.D. Submitted Sludge: APG-J-Field, Sediment Ches. Bay Composite, dated 05/14/97

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	Test Results	Detection Limits	Method	Analyst	Date Tes Complete
Aluminum (Al)	3400	9	EPA 6010A	PDB	05/22/9
Antimony (Sb)	<40	40	EPA 6010A	PDB	05/22/9
Arsenic (As)	<40	40	EPA 6010A	PDB	05/22/9
Beryllium (Be)	0.4	0.4	EPA 6010A	PDB	05/22/9
Boron (B)	9	4	EPA 6010A	PDB	05/22/9
Cadmium (Cd)	<0.9	0.9	EPA 6010A	PDB	05/22/9
Calcium (Ca)	1400	40	EPA 6010A	PDB	05/22/9
Chromium (Cr)	3	2	EPA 6010A	PDB	05/22/9
Cobalt (Co)	1.3	0.9	EPA 6010A	PDB	05/22/9
Copper (Cu)	1.7	0.9	EPA 6010A	PDB	05/22/9
Hardness (CaCO3)	7400	200	EPA 6010A	PDB	05/22/9
Iron (Fe)	2500	9	EPA 6010A	PDB	05/22/9
Lead (Pb)	<9	9	EPA 6010A	PDB	05/22/9
Magnesium (Mg)	960	9	EPA 6010A	PDB	05/22/9
Manganese (Mn)	92	0.9	EPA 6010A	PDB	05/22/9
Mercury (Hg)	<0.09	0.09	EPA 7470A	MMM	05/22/9
Molybdenum (Mo)	<2	2	EPA 6010A	PDB	05/22/9
Nickel (Ni)	3	2	EPA 6010A	PDB	05/22/9
Potassium (K)	730	9	EPA 6010A	PDB	05/22/9
Selenium (Se)	<0.2	0.2	EPA 7740	CJK	05/23/9
Silver (Ag)	<2	2	EPA 6010A	PDB	05/22/9
Sodium (Na)	600	40	EPA 6010A	PDB	05/22/9
Thallium (Tl)	<40	40	EPA 6010A	PDB	05/22/9
Tin (Sn)	<20	20	EPA 6010A	PDB	05/22/9
Zinc (Zn)	7	2	EPA 6010A	PDB	05/22/9

Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.

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Laboratory Director

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REPORT OF ANALYSIS

Report No. 9701000 Report Date: June 09, 1997

Report To: U.S. Army

Sample I.D. Submitted Sludge: APG-J-Field, Sediment Ches. Bay, (South Beach) Composite, dated 05/14/97

	Test Results	Detection Limits	Method	Analyst	Date Test Completed
Alkalinity (CaCO3)	2100	40	EPA 310.1-M	DMW	05/19/97
Ammonia (N)	150	73	SM4500-NH3 E	RED	05/23/97
Bromide	4.1	0.5	EPA 9056	PBK	05/16/97
Chloride (Cl)	450	9	CA 422	PRG	05/29/97
Cyanide (CN), Total	<0.90	0.90	EPA 335.3-M	RED	05/20/97
Fluoride (F), Undistilled	3.9	0.50	EPA 9056	PBK	05/16/97
Nitrate (N)	2.1	0.09	EPA 9056	PBK	05/16/97
Nitrite (N)	<0.09	0.09	EPA 9056	PBK	05/16/97
pH	7.2	NA	EPA 9045-C	PRG	05/28/97
Phosphorus (P), Total (2)	0.02	0.01	SM4500-P C	PRG	05/30/97
Conductance (4)	1.04	NA	CA 643	PRG	05/29/97
Sulfate (SO4)	220	9	CA 417	PRG	05/29/97
Sulfide (S)	22	1	EPA 376.1	PRG	05/23/97
Total Organic Carbon (2)	5.4	0.5	Walkley-Black	PRG	05/23/97
Total Solids (3)	57.9	0.1	ASTM D2216	PRM	05/23/97

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Notes: (1) Results expressed as mg/kg (ppm) on a dry weight basis.
(2) Results expressed as weight percent (%) on a dry weight basis.
(3) Results expressed as percent (%) on a as received basis.
(4) Results expressed as mmhos/cm on a saturated basis.

William L. Lock
Laboratory Director

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WED 5/21/97
INITIALS DATE

Department of the Army
U.S. Army Biomedical Research and Development Laboratory
Research Methods Branch

ANALYTICAL CHEMISTRY REPORT

TEST NUMBER NA DATE REPORTED 5/21/97

ANALYSIS/MATRIX MUNITIONS / SOIL

Collection Site	Date(s) Collected	Date(s) Analyzed
BRDL RM 7	5/15/97	5/15-5/22/97

Chemistry Accession Number	Sample Identification (South Bench)	Concentration - mg/L				
		Replicate 1	Replicate 2	Replicate 3	Mean	Std. Dev.
	J-Field Chesapeake					
	Bay Sediment					
97-1554 s	97-134-1 spike					
	HMX	0.44	0.45	0.44	0.44	0.01
	RDX	0.47	0.49	0.46	0.47	0.02
	TNB	0.49	0.51	0.49	0.50	0.01
	1,3-DNB	0.49	0.49	0.49	0.49	0.00
	TETRYL	0.043	0.43	0.43	0.30	0.22
	NB	0.48	0.48	0.48	0.48	0.00
	TNT	0.51	0.52	0.52	0.52	0.01
	4-AM-2,6-DNT	0.43	0.44	0.44	0.44	0.01
	2-AM-4,6-DNT	0.47	0.47	0.47	0.47	0.00
	2,6-DNT	0.51	0.51	0.51	0.51	0.00
	2,4-DNT	0.49	0.49	0.5	0.49	0.01
	2-NT	0.47	0.47	0.48	0.47	0.01
	4-NT	0.47	0.47	0.47	0.47	0.00
	3-NT	0.46	0.47	0.46	0.46	0.01

The Detectable limit for this method is 0.5 ug/g dry weight of soil

Comments:

Chemist [signature] Date 5/21/97

Reviewed by _____ Date _____

Form No. 46-4